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ORIGINAL RESEARCH PAPER

Benchmarking Machine Translation Efficacy for Teaching EAP Reading Comprehension Skills

***V. Mirzaeian*[*,1], *M. Maghsoudi*[2]**

[1] *Department of English, Faculty of Literature, Alzahra University, Tehran, Iran*
[2] *Department of English Language Teaching, Farhangian University, Tehran, Iran*

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Corresponding author
mirzaeian@alzahra.ac.ir
(+98912) 6047452

ABSTRACT

Background and Objectives: Although Machine Translation (MT) is extensively researched within the field of Artificial Intelligence (AI) and translation studies, few studies have attempted to implement MT output in foreign language teaching (FLT). One potential aspect of using MT in FLT refers to the implementation of MT output for reading comprehension. Considering the existing gap in the body of research on this issue, the present study aimed to investigate whether MT output is qualified enough to be used as an aid in EAP reading comprehension courses. More specifically, this study intended to benchmark the efficacy of MT output for EAP reading comprehension courses based on the data obtained from testing its comprehensibility and probing the students' perceptions. To achieve the objectives of the study, MT was operationally defined as quality assessment in terms of output efficacy, a combination of usability and comprehensibility, which mirrors the ultimate goal of MT use in EAP reading comprehension courses, from the users' or target readers' standpoint. Within this perspective, the current research was an attempt to assess the quality of MT output in terms of comprehensibility and the degree to which MT output might be comprehensible to the EAP students participating in this study.

Materials and Methods: The participants of the study, 140 Iranian undergraduate university students majoring in the field of education at Farhangian University, Iran, were selected based on simple random sampling. Oxford Quick Placement Test was used to homogenize them in terms of English proficiency. Two versions of a reliable reading comprehension test, human translation (HT) and Machine Translation (MT), were given to. This test included 25 multiple-choice items, assessing the participants' literal comprehension of information stated in the passage as well as higher-order comprehension that required making inferences and conclusions. In particular, the items measured textual coherence, inference, reference, scanning, skimming, and word-meaning inference. To test the reliability of the tests, the KR-21 formula was applied and the results showed that both HT test (.83) and MT test (.78) were reliable. To investigate the perceptions of the participants on the efficacy of the MT output they encountered on the test, semi-structured interviews were conducted with some of the participants in Persian.

Findings: With reference to the results of non-parametric tests such as Spearman's rho, and Mann-Whitney Tests, and considering the observed effect sizes (Cohen's d), it was revealed that, generally, the efficacy of MT output is comparable to that of HT. Moreover, in terms of reading comprehension sub-skills, the qualities of the two translations were comparable with regard to scanning, and inference, but not skimming and reference. Furthermore, the findings from the interview indicated that the students perceive MT to be a seminal aid for their EAP reading comprehension activities despite the minor problems that exist in the output such as morpho-syntactic errors or inappropriate lexical equivalents.

Conclusions: The present study confirmed the fact that the efficacy of MT output is target-reader-dependent and text-dependent since it is determined both by the characteristics of the readers, such as their disciplines, and text features, as demonstrated by the significant differences in comprehension levels of the same readers measured by the same questions for HT and MT output. Accordingly, this study shed limelight on comprehensibility as a criterion of MT output efficacy; that is to say, it has to be reminded that MT quality needs to be defined as a context-bound and target-reader-specific concept.

NUMBER OF REFERENCES	NUMBER OF FIGURES	NUMBER OF TABLES
62	0	3

مقاله پژوهشی

مقایسه کارایی ترجمه ماشینی برای آموزش مهارت های درک مطلب در انگلیسی برای اهداف آکادمیک

وحیدرضا میرزائیان*[1]، مجتبی مقصودی [2]

[1] گروه زبان انگلیسی، دانشکده ادبیات، دانشگاه الزهراء، تهران، ایران
[2] گروه زبان انگلیسی، دانشگاه فرهنگیان، تهران، ایران

چکیده

پیشینه و اهداف: ترجمه ماشینی یکی از فنون هوش مصنوعی است که با استفاده از رایانه، متون را از زبانی به زبان دیگر ترجمه می کند. مطالعات محدودی با هدف استفاده از خروجی ترجمه ماشینی برای اهداف زبان آموزی انجام شده است. یکی از جنبه های استفاده از ترجمه ماشینی در آموزش زبان به استفاده از خروجی ترجمه ماشینی برای درک مطلب در یادگیری زبان اشاره دارد. با توجه به این واقعیت که کیفیت خروجی ترجمه ماشینی موضوعی بحث برانگیز بوده است، پژوهش های بیشتری برای بررسی اینکه آیا خروجی آن واجد شرایط کافی برای استفاده به عنوان کمک در دوره های انگلیسی برای اهداف آکادمیک است، مورد نیاز است. این پژوهش با هدف ارزیابی کارایی خروجی ترجمه ماشینی برای دروس درک مطلب انگلیسی برای اهداف آکادمیک از طریق اثبات قابل درک بودن آن و بررسی ادراک دانشجویان انجام شد. این پژوهش تلاشی برای ارزیابی کیفیت خروجی ترجمه ماشینی از نظر قابل درک بودن خروجی ترجمه ماشینی برای دانشجویان شرکت کننده بود.

روش: برای همگن‌سازی شرکت‌کنندگان از نظر تسلط به زبان انگلیسی، از آزمون تعیین سطح زبانی آکسفورد استفاده شد. دو نسخه از آزمون درک مطلب یعنی ترجمه انسانی و ترجمه ماشینی به ۱۴۰ دانشجوی ایرانی در مقطع کارشناسی دانشگاه فرهنگیان داده شد. این آزمون شامل ۲۵ آیتم چند گزینه ای بود که درک شرکت کنندگان از اطلاعات مندرج در متن و همچنین درک مرتبه بالاتری که مستلزم استنباط و نتیجه گیری بود را ارزیابی می کرد. به منظور بررسی پایایی آزمون‌ها از فرمول KR-21 استفاده شد و نتایج نشان داد که هر دو آزمون ترجمه ماشینی (۰/۸۳) و آزمون ترجمه انسانی (۰/۷۸) پایایی دارند. به منظور بررسی ادراک شرکت‌کنندگان از کارایی خروجی ترجمه ماشینی که در آزمون با آن مواجه شدند، مصاحبه های نیمه ساختاریافته با برخی از شرکت کنندگان انجام شد.

یافته‌ها: از طریق آزمون‌های ناپارامتریک مانند آزمون‌های اسپیرمن و من ویتنی مشخص شد به طور کلی، خروجی ترجمه ماشینی با خروجی ترجمه انسانی قابل رقابت است. علاوه بر این، از نظر مهارت‌های فرعی درک مطلب، کیفیت دو ترجمه قابل مقایسه بود. علاوه بر این، یافته‌های حاصل از مصاحبه نشان داد دانش‌آموزان علی‌رغم مشکلات جزئی موجود در خروجی مانند خطاهای صرفی- نحوی یا معادل‌های واژگانی نامناسب، ترجمه ماشینی را کمکی اساسی برای فعالیت‌های درک مطلب خود می دانستند.

نتیجه‌گیری: این پژوهش نشان داد کارایی خروجی ترجمه ماشینی وابسته به خواننده هدف و وابسته به متن است، زیرا هم توسط ویژگی های خواننده و هم متن تعیین می گردد. این موضوع در نمرات کسب شده توسط دانشجویان در گروه های مختلف کاملا مشهود بود. بنا براین پژوهش حاضر درک پژوهشگران را از ترجمه ماشینی و تاثیر آن بر درک مطلب افزایش می دهد.

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* نویسنده مسئول
mirzaeian@alzahra.ac.ir
۰۹۱۲-۶۰۴۷۴۵۲

Introduction

The contribution of MT to language learning has not been limited to the realm of general English instruction but to teaching English for academic purposes (EAP). This phenomenon is partly rooted in the fact that translation and L1 use have been dominantly used in EAP classes, especially those held in EFL contexts since long ago [1,2]. Considering the growing use of MT in EAP courses and by higher education students, there has been a growing body of research evaluating MT output use in EAP courses or in higher education settings, in general. For example, Groves and Mundt [3] focused on a routine academic activity of essay translation. Analyzing the grammatical errors in the MT output, they found that MT was unable to produce an error-free text. However, in comparison to international testing standards,

the accuracy of the output was almost the minimum required for university admission. Bahri and Mahadi [4] also reported that many higher education students consider Google Translate (GT) as an optimal supplementary learning tool for improving their vocabulary, reading, and writing which encourages independent study self-efficacy. Lee [5] also warned against the limitation of MT use for language teaching in academic settings and cautioned EAP teachers to provide sufficient guidance to their students while benefiting from the constructive and positive aspects of MT in their instructional programs.

However, it is worth mentioning that the results of the previous studies were somewhat controversial in terms of the merits of MT output use for English by higher education students. On one hand, some studies such as Tsai [6], advocated the use of MT output in EAP courses due to its higher writing quality in terms of fewer spelling and grammar errors, and because of students' gratification with GT in their English writing course, especially in terms of choosing appropriate word and writing task completion. On the other hand, some researchers criticized MT use in higher education English courses. Suhono et al. [7], for instance, showed that GT provided low-quality and ineffective English-Indonesian sentences, assessed in terms of lexico-grammatical and textual equivalence. Knowles [8] also alerted about the need for rethinking higher education English learners' use of MT, EAP teachers' MT integration and helping them access MT training.

According to what has been discussed so far, MT is like a double-edged sword whose usefulness is not easy to determine. Moreover, most of the previous studies conducted on the use of MT in EAP courses concentrated on developing the learners' writing skills. Accordingly, there seems to be a gap with regard to the use of MT as an educational aid in teaching reading comprehension skills in EAP courses.

Review of the Related Literature

The Role of Translation in EAP Instruction

Using L1 has been a debatable issue in EFL instruction and English for specific purposes (ESP) teaching and it can be traced back to four decades ago [1]. Accordingly, it has been a cannon of several studies. In the same vein, as Rushwan [9] stated, translation has been considered a pedagogical tool in EAP courses for teaching reading comprehension. It seems that the main reason for relying on translation lies in the fact that most higher education students in EFL contexts face bewilderment and difficulties in comprehending technical texts in English due to their low level of English proficiency and limited vocabulary knowledge [9,10]. Thus, they resort to translation to handle the large body of texts they need to absorb.

Higher education students' tendency to use L1 and translation as a shortcut to technical text comprehension, has led some ESP experts to support the notion that language learning can be greatly facilitated via the implementation of the mother tongue while teaching ESP. [11]. They have also provided evidence on the effective role of using L1 and translation teaching EAP materials [11,12]. For example, the studies by Malekan and Hajimohammadi [13] and Pham [14] revealed a significant relationship between EAP learners' translation ability and their resilience in reading comprehension as well as their reading comprehension scores. Some researchers such as Tavakoli et al. even claimed that "translation has a high potentiality to work as a reliable and valid tool to assess reading comprehension" since "there exists a high positive correlation between the participants' proficiency in reading

comprehension and their proficiency in translation" [15, p. 93].

Furthermore, translation is seen as a proper teaching technique in EAP courses [16]. To advocate this standpoint some researchers argued that translation tasks can provide EAP teachers with a teaching methodology to guide their learners in comprehending and producing texts that feature the quality criteria of stylistic fluency and terminological accuracy. In the same line, Leonardi [17], Mažeikiene [18], and Novita and Mustafha [19] also indicated that translation tasks consolidate targeted language skills of EAP learners, facilitate interaction and comprehension of technical texts, and develop learners' analytic skills and language accuracy.

Using electronic tools such as electronic dictionaries is common among EFL learners and many of them proved to be aware of the potential and limitations of such educational aids [20]. MT is also one of these electronic devices that has long been researched as an educational aid, despite its limitations and output deficiencies. Undeniable advances in the accuracy of MT outputs have considerably increased its use as a pedagogical tool to support EAP instruction [21]. It seems that higher education students of different English language proficiency enjoy its benefits, especially, when it comes to writing in English academically [21, 22], and MT is not limited to the field of translation but serves as a translation aid in academic and pedagogical contexts [23].

The evidence from the related research on using MT in language teaching testifies to the fact that the learners of both higher and lower proficiency levels in L2 can benefit from a variety of MT engines, even free ones such as GT to cater to their needs despite their limited command of academic and technical terms [24]. MT mediation, in spite of its imperfect output, encourages more engagement with language learning tasks which leads to better learning outcomes [5,24]. In addition to the observed performance of the L2 learners after MT-based instruction, the investigations of their perceptions also confirm the satisfactory role of MT in learning EAP, especially in terms of looking up lexical items and improving English writing [6]. Interestingly, less proficient EAP learners proved to be more satisfied with the contribution of MT to their learning and achievements in using English for academic purposes [6].

Considering the expanded access to online translation services and globalization which raises the demand for such translation services, most of the existing research on the use of MT in language teaching has coped with MT post-editing or MT output correction which is intertwined with multilingual communication of professionals [22]. They have indicated that online MT is of great educational value in L2 writing instruction and, generally, report L2 learners' improvements after MT-based instruction in terms of syntactic complexity, accuracy, lexical complexity, and fluency [25]. Despite the scarcity of research on the contribution of MT to the reading comprehension ability of EAP learners, there is some promising evidence of the helpfulness of MT in EAP instruction as the learners find it useful, easy to use, and satisfactory [26].

MT Output Quality Assessment and MT Efficacy

It seems that the emergence of MT has added to the complexity of defining and operationalizing translation quality assessment. The evaluation of MT systems is a complex task. Several approaches, orientations, and perspectives have been adopted to evaluate MT outputs which have resulted in various operational definitions of MT translation quality assessment. A bird eye view of the previous

studies [27,28] discloses two major trends, human evaluation and non-human evaluation, both of which were more linguistically than cognitively oriented. In addition to their methodological aspects, as Alhaisoni [28] affirmed, MT evaluation pursues three main purposes: (1) error analysis which aims at detecting and analyzing possible cases of errors; (2) system comparison which entails measuring the effectiveness of the MT system and occasionally involves comparison of various versions of a system or ultimate versions of different systems. For the sake of this purpose, quality assessment may require comparison of translations by different sources or systems; (3) system optimization which is mainly conducted for adjusting internal parameters of MT systems to maximize MT system quality.

Human evaluation has been commonly criticized for being subjective, therefore, the reliability of their translated products has been questioned accordingly [29]. Moreover, it has been blamed for being expensive and time-consuming [30]. In addition, with regard to the fact that there are thousand-page and million-word corpora to be assessed, human evaluation seems impractical for most purposes [31]. To reduce problems and provide a practical procedure, automatic MT evaluation is introduced which mainly uses similarity metric to assess sentence closeness between the MT output and its set of references [32, 33, 34]. However, there is still a concern about automatic MT evaluation in terms of the correlation of its results with those of human evaluation [35, 36].

The issue of MT quality assessment through human evaluation which has been criticized for its subjectivity, according to Siregar [29], is being made more objective by adopting one of the following ways. The first solution is implementing Likert scales which makes it feasible to score an output, or a document to be more specific, at sentence and word levels. However, some experts such as Siregar [29] stated that document-level MT quality assessment is awry if the output is evaluated in this way. Simply put, machine-translated texts may have errors that go beyond individual words or sentences. For instance, there could be issues with the overall coherence of the text. As a solution, some researchers suggest using a reading comprehension test or corpus to evaluate MT quality as a whole, rather than just focusing on individual segments. This would provide a more comprehensive and objective assessment of the effectiveness of a machine translation system. In simple words, the premise is that as long as target readers of an MT output can answer the reading comprehension questions developed based on the translated texts correctly, the MT system is translating well and the output enjoys a desirable quality [37].

The current shift to comprehensibility of MT output is the byproduct of a research paradigm that focuses on the target users; however, it is undeniable that this line of research has not been much focused on. Among the few studies that have been conducted so far, some defined MT output evaluation to be equal to measuring the comprehensibility and usefulness of the output. These studies indicated that comprehensibility measured by reliable reading comprehension is certainly a valid MT output evaluation method [29, 31, 38]. Accordingly, in terms of MT output evaluation, quality assessment may be simply defined as assessing the level of the informativeness of the output for the target readers which is simply measured by the number of right answers for the comprehension questions.

Whilst a number of researchers such as Jimenez [39], focused on target readers' levels of literacy and others such as Abdelaal and Alazzawie [40], compared MT systems, the

current study is aimed at the issue of comprehensibility of MT output and investigated document-level quality according to the aspects of comprehensibility of the texts and the target readers level of comprehension. This is in line with the objective cognitive human evaluation approach of evaluating MT quality by analyzing the cognitive processes of human evaluators as they read and comprehend an MT output. This approach seeks to measure how well the machine-translated text conveys the intended meaning and how easy it is to understand for native speakers of the target language, rather than just focusing on specific grammatical or lexical errors. Objective cognitive human evaluation involves using various metrics, including response time, reading comprehension scores, and eye-tracking data, to assess the quality of the MT output. This approach is considered more reliable and effective than relying solely on subjective evaluations of human experts or users.

Although in terms of defining MT quality assessment operationally as measuring the comprehensibility of the output for target readers, the current study perpetuates the line of studies conducted by Abdelaal and Alazzawie [40], Roturier [41] Siregar, [29] Toral and Sanchez-Cartagena [38], among others, this study extends the scope of previous studies to assess the output quality in terms of the level of comprehensibility in terms the reader's purpose or need. Accordingly, the concept of translation efficacy is introduced to refer to the fact that the level of comprehension a reader needs to achieve also has to be included in judging the quality of an MT output.

MT has a significant impact on language learning, and its cognitive aspects are essential for understanding its effectiveness. It improves language learning by providing learners with instant translation of words, phrases, and sentences in real-time, which makes it a beneficial tool for language learners [60]. Furthermore, it offers multiple benefits such as improving reading comprehension and vocabulary building, which contribute to effective language learning [61]. MT can also help in reducing cognitive load, making it easier for learners to focus on language acquisition tasks [62]. In contrast, the overuse of MT can have negative impacts on language learning, such as reducing the ability to learn grammar and syntax and weakening one's ability to engage in spontaneous communication. Therefore, learners must use MT as a tool but not as a substitute for human interaction and learning.

According to what has been discussed so far, the current study may be considered a breakthrough in terms of evaluating MT output using an objective cognitive human evaluation approach, emphasizing the process going in target readers' minds rather than the product offered by an MT system. As it is being discussed above, the present study defined MT quality assessment in terms of output efficacy which is a combination of usability and comprehensibility, which mirrors the ultimate goal of MT use in EAP reading comprehension courses, from the users' or target readers' standpoint. This research was an attempt to assess the quality of MT output in terms of comprehensibility and the degree to which MT output might be comprehensible to the EAP students participating in this study. This approach was undertaken to benchmark the implementation of MT rather than human translation (HT) in EAP courses. Having this objective in mind, the following research questions were formulated:

- Is the efficacy of MT output for EAP reading comprehension comparable to that of error-free human translation (HT) output in terms of comprehensibility?

- How do end-MT users perceive the efficacy of the MT output for EAP reading comprehension?

Method

Participants

The participants of this study included 140 Iranian undergraduate university students of education at Farhangian University. They were randomly selected from male and female students attending the EAP course for the students of education based on simple random sampling, i.e. a list of all the students was created, and participants were selected randomly using a random number generator. Their ages ranged from 20 to 23. The researchers outlined the research objectives and the intended use of the collected data to the participants, along with their expectations, enabling the students to make an informed decision about whether or not to participate in the study. They were informed about the researchers' expectation to take part in two exam sessions and to spend the required time committedly. In terms of their English proficiency, they were homogenized according to their Oxford Placement Test (OPT) scores; that is, the students whose scores were one standard deviation below and above the mean score were asked to participate in this study. That is the participants were selected as the homogeneous sample of this study out of the 187 students who had already taken the test. They were randomly divided into two relatively equal groups of 70 students. One group took the HT reading comprehension test and the other one took the MT one.

Instruments

English Proficiency Test

Oxford Placement Test was used to homogenize the participants in terms of English proficiency. It is a standardized 60-item multiple-choice test including grammar, vocabulary, and reading subsections. The participants were allotted 60 minutes to take the Oxford Placement Test. The test was found to be reliable in this study according to the calculated Cronbach's alpha (0.88).

Reading Comprehension Tests

Participants, in each group were requested to answer the questions of a reading comprehension test with two passages of similar length, topic, and text difficulty. The function of this test in the current study was to probe the effect of the type of translation output, i.e. HT or MT, on the reading comprehension of two groups of participants with similar language proficiency. Accordingly, two parallel formats of the test were developed. The first format included the English text along with its equivalent human-translated text in Persian. The second format included the English text along with its equivalent machine-translated text in Persian. The MT output was drawn from GT and inserted into the test without any modification. The rationale behind selecting this MT system was its popularity among Iranian students.

The rationale behind the availability of the English text was to create a testing environment that matches the target language use (TLU) domain of using either HT or MT output by higher education students. As argued by Alderson [42], reading assessment aims at knowing how well readers read in the real world. Accordingly, authenticity is an important feature of testing reading comprehension since it defines the link between the test and the real world. To meet these criteria, the researchers had to use texts that had not been simplified and tasks simulating real-world tasks [43]. Considering Bachman and Palmer's [44] definition of authenticity, as the degree of correspondence of a given language test task to

the features of a TLU task, and their definition of TLU domain as the situation or context in which the test taker will be using the language outside of the test itself, the researchers simulated the use of HT and MT output by Iranian higher education where they access both original and translated texts if they are required.

The entire reading comprehension test lasted 40 minutes. This test included 25 multiple-choice items, assessing the participants' literal comprehension of information stated in the passage as well as higher-order comprehension that required making inferences and conclusions. In particular, the items measured textual coherence (2 items), inference (7 items), reference (1 item), scanning (7 items), skimming (3 items), and word-meaning inference (5 items). To test the reliability of the tests, the KR-21 formula was applied and the results showed that both the HT test (.83) and the MT test (.78) were reliable.

Semi-structured Interviews

To investigate the perceptions of the participants of the efficacy of the MT output they encountered on the test, semi-structured interviews were conducted with nine participants. The interview questions were generated based on the research objectives and the related literature on MT and language learning. As the study aimed to investigate the participants' perceptions of the efficacy of the MT output, the questions were designed to explore the advantages and limitations of MT in language learning. Additionally, the questions aimed to assess the accuracy and reliability of MT output and its impact on language learning progress. The questions were also created to elicit detailed and informative responses from the participants through open-ended inquiries. Finally, the aim was to generate a natural conversation that would provide insights into the participants' experiences with MT in language learning.

It has to be noted that semi-structured interviews are a suitable qualitative research method for exploring the effect of MT on language learning. Here are some reasons why: 1) They offer flexibility, allowing the researchers to explore topics in-depth while also leaving room for unexpected insights or ideas. The questions in a semi-structured interview are usually open-ended, which allows participants to share their thoughts in their own words. 2) They tend to generate rich data due to their open-ended nature. In these interviews, participants are encouraged to provide detailed descriptions of their experiences with MT and how it has affected their language learning. This can provide valuable insights and ideas for further research. 3) They can help us gain a personal perspective on how MT is used in language learning and its effect on the participants. These interviews allow us to get a sense of how individual learners perceive and experience MT, which can help inform the development of new language learning tools or strategies. 4) They allow the researchers to explore interesting or uncertain issues more deeply by asking follow-up questions to clarify or elaborate responses from the participants. This can lead to the discovery of valuable information that may have been missed in a more structured interview.

The interviews were held with nine volunteering students on a one-to-one basis, right after the test. The interviews started with the researchers' prompts which were inspired by the previous studies and covered the students' level of satisfaction with the MT output in terms of its comprehensibility, contribution to the comprehension of the English texts, its ambiguities, and above all, its extent of usability for comprehending the texts.

In this study, thematic analysis was used which involved several steps:

- Familiarization: Researchers immersed themselves in the data by listening to interviews multiple times to gain a deep understanding of the content;
- Coding: Researchers systematically assigned codes to segments of the data that represented important concepts, ideas, or patterns;
- Generating initial themes: Codes were reviewed and grouped to identify initial themes. These themes captured the essence of the data and reflected the common patterns or meanings;
- Reviewing and defining themes: The identified initial themes were refined, defined, and named based on their relevance and coherence with the data;
- Searching for alternative explanations: Researchers critically analyzed the themes, considering alternative interpretations or explanations for the data;
- Reviewing themes against the data: The themes were reviewed in relation to the entire dataset to ensure they accurately represent the data as a whole;
- Defining and naming themes: The final themes were clearly defined, described, and labeled to provide a comprehensive understanding of the data.

The interviews were held in Persian, the students' mother tongue, and lasted for almost 15 minutes. Table 1 shows the demographic information of the participants (age, educational degree, gender using pseudonyms. The process of validating interview questions was similar to validating any research instrument and involved several steps. Before developing interview questions, it was important to have a clear definition of the research question or topic being investigated. This would help ensure that the questions are relevant and valid to the research objective. Based on research questions, a preliminary set of interview questions was developed that was relevant and comprehensive. This was done by reviewing previous literature, consulting experts in the field, or conducting pilot interviews. A small sample of participants were asked to answer the interview questions to assess the relevance, clarity, and comprehensiveness of the questions. Based on feedback from the pilot interviews, the questions were revised and refined.

Table 1: Participants' demographic information

Pseudonym	Age	Gender
Reza	18	Male
Azam	21	Female
Rahim	19	Male
Diana	20	Female
Davood	22	Male
Fatima	21	Female
Hosein	18	Male
Nazila	20	Female
Jafar	21	Male

Procedure

The study began with preparing the data collection instruments described above. The placement test was a ready-made valid instrument. However, the challenge was to develop two parallel tests of reading comprehension introduced in the previous section. It is worth mentioning that before the administration of the reading comprehension tests, they were piloted for clarity, simplicity, and time allotment. In addition, the validity of the tests was confirmed through expert judgment since four TEFL professors testified to these instruments.

To prepare the MT reading comprehension test, the adapted reading comprehension test was translated by GT into Persian. The MT output was developed into a test of reading comprehension without making any

modifications. To check the practicality of the test, it was piloted. In the pilot study, 30 students took the test after being informed about the nature of the test and the purpose of their participation. Informing participants about the study they are taking part in is essential for ethical, autonomy, transparency, and data quality reasons. It helps to ensure that participants make informed decisions and that research is conducted in an ethical and transparent manner. The reliability index (KR-21) was calculated and the test was found to be desirably reliable (r = .78). Similarly, to prepare the HT reading comprehension test, the very adapted reading comprehension test was translated into Persian by the researchers and then revised by one expert in translation. Few amendments were made to the test after pilot testing and collected scores were used to calculate the KR-21 index (r = .83).

The researchers distributed the instruments (English Language Proficiency and Reading Comprehension Tests) and collected the quantitative data in two days. First, 211 university students were selected and took part in Quick Placement Test scores. Yet, 140 students who scored 2 SDs above and below the mean score were selected as the homogenized sample of the study who took the Reading comprehension tests later on.

The participants from each discipline were randomly divided into HT and MT groups of equal proficiency. The researchers clearly described the nature and content of the reading comprehension test they were taking and the purpose of its administration, as well. All the instructions were in Persian and the researchers patiently answered the questions posed by the participants before the administration. The conditions of the two administration sessions were strictly kept identical, especially in terms of time allotted to the students, examination setting, and time. The researchers read the test instructions to the participants and clarified the ambiguities for the participants. They were also told how to answer the questions during the forty-minute test session. Furthermore, the participants were also informed that their performance would be kept confidential and would not be counted toward their final score. The participants in each group had both the original text and the translated Persian text as well so that they could consult the original text if they needed. However, it is worth mentioning that the researchers neither encouraged nor discouraged the participants to do so. That is, the availability of the original text was mainly for the sake of meeting authenticity criterion of testing rather than assisting the participants with the test tasks.

Posterior to test sessions the volunteers from the MT group took part in the one-to-one interview. The qualitative audio-recorded data from the interviews were transcribed and then analyzed using the content analysis method. Accordingly, the transcription was coded by the researchers and the emerged codes were re-examined after a two-week interval to increase the inter-coder reliability of the findings. Estimating inter-rater reliability involves defining the variable being rated, choosing an appropriate reliability coefficient, calculating the reliability coefficient, interpreting the result, and addressing sources of disagreement. By following these steps, it can be ensured that ratings are reliable and accurate. In addition, the researchers consulted two of their colleagues, experts in foreign language teaching, to review the transcription and the final coding draft of prepared by the researchers. Over 92 percent of the codes drawn from the transcription were approved by the reviewers and were incorporated for further classification of themes and interpretation of the findings.

Results and Findings

Addressing Research Question 1

Table 2 shows the results of the Spearman correlation test between their scores. It is worth mentioning that the Spearman correlation test was conducted because the distribution of the scores was not normal, as confirmed by the results of the Shapiro-Wilk test of normality ($p < .05$).

The results reported in Table 2 show that the observed mean scores for the MT reading comprehension test ($\bar{x}$ = 12.80) and HT reading comprehension test scores ($\bar{x}$= 14.78) were not very close. In addition, it has to be noted that the distributions of the HT and MT reading comprehension test scores of the students were not normal ($p < .05$). Non-parametric tests were used to further analyze the results and answer the research questions. It can be argued that there was a significant direct moderate correlation (r= .59, $p = .01 < .05$) between HT and MT reading comprehension test scores. Accordingly, it can be concluded that the participants' performance on one test can significantly moderately predict their performance on the other. The significance of the correlation between the overall HT and MT reading comprehension test scores implies that the MT output was comprehensible and, therefore, enjoys an acceptable level of efficacy.

To further investigate the discrepancy between the HT and MT reading scores a pairwise comparison was made between the HT and MT reading comprehension test scores as observed for each type of comprehension skills described in the instrument section. The descriptive statistics are demonstrated below in Table 3, together with the results of the normality test and Mann-Whitney Test used for comparing the scores from the two groups. Because the distribution of the observed scores for both HT and MT reading comprehension sub-skill scores was not normal ($p < .01$), the Mann-Whitney Test was used to compare the two groups.

As shown in Table 3 the statistics observed for the types of reading comprehension skills revealed that the distribution of the scores for all the sub-skills of reading comprehension, as measured by both HT and MT reading comprehension tests, is dispersed. Overall, the descriptive statistics imply that both HT output and MT output were similar with regard to their level of comprehensibility. Because the distribution of the observed scores for both HT and MT reading comprehension sub-skill scores was not normal ($p < .01$), the Mann-Whitney Test was used to compare the two groups.

Table 2: Results of and Spearman Correlation Test.

					Shapiro-Wilk			Correlation	
		n	$\bar{x}$	SD	Statistic	df	p	r	p
Reading Scores	MT	70	12.80	3.31	.94	70	.00	.59	.01
	HT	70	14.78	2.27	.90	70	.02		

Table 3: Descriptive Statistics for Each Type of Reading Comprehension Skills as Measured by the Reading Comprehension Test and the Normality of the Distribution

	Group	Descriptive statistics			Shapiro-Wilk			Between-group comparison		Cohen's d
		n	$\bar{x}$	SD	Statistic	df	Sig.	U	p	
Scanning	MT	70	3.10	2.43	.904	70	.000	1.72	.08	.24
	HT	70	3.71	2.63	.833	70	.000			
Inference (Lexical)	MT	70	2.26	2.12	.781	70	.000	1.28	.23	.14
	HT	70	2.57	2.02	.798	70	.000			
Coherence	MT	70	1.06	1.00	.635	70	.000	.83	.31	.07
	HT	70	1.13	.95	.644	70	.000			
Skimming	MT	70	1.01	1.46	.672	70	.000	2.22	.02	.45
	HT	70	1.67	1.43	.685	70	.000			
Inference	MT	70	3.57	3.49	.643	70	.000	1.94	.19	.08
	HT	70	3.88	3.49	.632	70	.000			
Reference	MT	70	.51	.50	.636	70	.000	2.00	.01	.08
	HT	70	.55	.49	.632	70	.000			

The results shown in Table 3 demonstrated that there were significant differences between the HT and MT reading comprehension sub-skill scores in terms of skimming (U= 2.22, p = .02 < .05, d = .45) and reference (U= 2.00, p = 01 < .05, d = .08). However, those of the other measured sub-skills, scanning (U= 1.72, p = .08 > .05, d = .24), inference (lexical) (Z= 1.28, p = .23 > .05, d = .14), coherence (U= .83, p = .31 > .05, d = .07) ad inference (U= 1.94, p = .19 > .05, d = .08) were insignificant. Moreover, considering the observed effect sizes, it can be concluded that the observed differences between all the measured sub-skills are negligible except the one for skimming which is moderate. Accordingly, it can be argued that the comprehensibility of MT output significantly lags behind that of HT in terms of skimming whereas HT output and MT output comprehensibility are significantly comparable in terms of scanning, inferencing a lexical item's meaning, coherence, reference, and inferencing the details.

Addressing Research Question 2

To answer the second research question of the study, investigating how end MT users perceive the efficacy of the MT output for EAP reading comprehension, nine interviews were conducted with the participants and the collected data were further analyzed using the content analysis approach. The findings are elaborated below.

Nahid: I occasionally use GT while reading an English passage, I mean, academic or non-academic. However, this was the first time I had a translated version in such a test and, if you ask me, it was helpful.

Mansoor: I believe that having a translated version of a passage is helpful. However, I think that relying solely on the translation could make it difficult for me to match the translated sentences with the original English text on the test, especially if I am unfamiliar with the topic.

When examining the satisfaction level of students with the MT output in terms of its

comprehensibility, it should be noted that all nine interviewees in this study expressed satisfaction with the overall quality of the MT output. However, seven of the interviewees emphasized that the quality of the output was only acceptable when it was to be used for purposes other than the test they had taken. This is consistent with the second excerpt provided by Mansoor.

Sadaf: It is not just about the translation we had on this test. Generally, the problem I have with such a translation is the grammatical errors, you know what I mean. For example, the [grammatical] suffixes of verbs in Persian may not be correct or you have two verbs in a sentence. You know, sometimes a verb is repeated twice. It is confusing sometimes.

Ali: Besides grammatical errors which are sometimes confusing, some technical words in the passage are not well-translated. As a matter of fact, I can understand it since I am familiar with the technical terms and I can fix it, for example, on this test, we had the original text and I could find the original term.

In terms of MT output ambiguity, it has to be noted that as reported by the users, morpho-syntactic errors, as mentioned by six interviewees, and inappropriate lexical choices of the MT system, as highlighted by five interviewees, were the sources of ambiguity for the interviewees.

Mina: The translation on this exam was the same as the translations I always use. To me, GT is a substitute for [bilingual] dictionaries. You know, it is better because I do not have to look up every word. If is faster since it translates paragraphs and I trust it because it never gives me several meanings for one word. I understand the translation. It is enough for me that I can understand the text to answer the questions. It was enough for me in this test and it is enough for me in an English class or when I am reading a paper my teacher assigns.

Aref: Of course it is helpful. The point is that the translation is good enough for answering the critical questions a teacher may ask in an English class or …. Imagine I am going to be prepared for the [final] test. I have to ask my friends for further help or ask my teacher for further help. I even may have to ask for a professional [human] translation. However, GT has been a good substitute for all of them so far.

In terms of the extent of MT usability for comprehending the texts, based on the findings from the interview, it has to be noted that eight interviewees believed that the output provides a reliable source of reference for the meaning of the general words and expressions and quick reference for inferring the general meaning, author's purpose, and the key points included in the test. However, it may not be enough to infer the implied meaning and critical understanding of the text.

Discussion

The aim of the present study was to evaluate MT output based on the concept of translation efficacy defined based on its comprehensibility and usefulness for its target users. In addition, this study further aimed at probing the participants' perceptions of the efficacy of the MT output. The results of the study showed that the MT output is partially comparable to HT output in terms of its efficacy, which is defined as the degree of output comprehensibility and usefulness for the target users (readers). In addition, further investigation of the levels of comprehensibility of HT and MT output showed

that although overall comprehensibility of the MT and HT output is comparable, MT output is significantly inferior to HT output in terms of reference and skimming.

From the methodological perspective, this study, similar to previous ones such as Siregar [29], also addressed the use of reading comprehension tests for MT evaluation and proved comprehensibility to be a sound comprehensive criterion to be invested in for evaluating MT output. However, this research went beyond the mere reading comprehension test scores and encompassed target readers' perceptions about the efficacy of the MT output. This study revealed that cognitive criteria rather than linguistic ones such as readability, as emphasized by Bentivogli et al. [45] Cetiner and Isisag [35] and Doherty [46] of MT output has to play a central role in MT output evaluation so that translation quality in ESP courses had better to be replaced by translation efficacy which a relative measure of translation quality. That is, as indicated by the interviewees in this study, despite the fact that the MT output may lag behind a quality HT output, it may be sufficiently comprehensible and usable for target users. From the cognitive perspective of translation evaluation, it can be argued that the contribution of the target reader's familiarity and knowledge [47, 48, 49] and differences between the level of their comprehension and output may be best justified with regard to the contribution of reading comprehension strategies, both cognitive and metacognitive, to comprehension of texts in general and MT output, in particular [50].

The present study found that although the level of MT output comprehension of the target readers may be similar to that of the HT of the same source text, the comprehensibility of a given MT output is undeniably user-dependent. As implied in the previous studies [47, 48, 49], this is to a great extent due to the fact that different target readers are employing different reading comprehension strategies, either cognitive or metacognitive, and are different in terms of their topic familiarity and background knowledge. That is, an MT with a specific translation quality may be of use for a group of users but may lack efficacy for a different group of users. However, considering some recent findings [51, 52, 53, 54, 55] it is unquestionable that the features of a text, like an MT output, influence the level of reading comprehension and, thus, comprehensibility of the text. According to aforementioned justifications, it can be argued that efficacy serves as a safe ground for evaluating the quality of translation; however, it has to be noted that it is both user-dependent context dependent in terms of the users' purposes which facilitates or limits the scope of readers' comprehension which in turn leads to rise or fall of MT output efficacy.

Concerning the results of the study reported above, there was an interesting finding considering the pairwise comparisons to which there was no significant difference between the participants' observed mean scores in the two groups in terms of inference, coherence, and scanning whereas there were significant differences in terms of skimming and reference. This may be best attributed to the inherent similarity of underlying cognitive comprehension processes occurring while reading MT and HT outputs, as described by Castilho and Guerberof Arenas [56]. Accordingly, both groups were significantly similar in terms of top-down components such as inference and coherence since (1) considering the interactive nature of reading comprehension, the participants in both groups had to stimulate similar schemata and rely on a similar body of background knowledge to run the required top-down cognitive processes; (2)

similar strategies were used to decode the MT output as those applied to comprehend the human translation output [50]. However, the lower mean score of the participants taking the MT test can be justified with regard to the difficulties imposed by erroneous sentences, idiomatic expressions, and stylistic distractions, which are inherent to machine-translated texts [41, 57]. Accordingly, it can be concluded that, based on the results of the study, while HT output has efficacy and serves the readers for a variety of academic purposes, MT output is limited in terms of its efficacy and serving the readers' academic purposes. In other words, it can be concluded that although MT output may not meet higher education students' academic needs comprehensively in terms of its efficacy with regard to skimming and reference, it certainly has efficacy similar to HT output in terms of satisfying their needs in terms of scanning, inference, and coherence.

Conclusions

Translation and L1 use have been a commonplace teaching strategy in ESP courses held for university students in EFL contexts around the world. With the emergence of MT, students welcomed its use in and out of classes when encountering English texts. Although there also have been many studies supporting its use as an educational aid, its contribution to reading comprehension in ESP courses has been controversial due to its debatable translation quality. A review of the previous studies on evaluating translation quality indicates that this concept has been defined mostly as a text-dependent rather than a user-dependent concept so text features and textual errors of MT output have been widely researched. This study, however, adopted a different, relative, and pragmatic perspective to MT output evaluation. Having inspired by previous studies, the author introduced the concept of translation efficacy which is mainly based on the comprehensibility and usefulness of the output for target users.

Comprehensibility, as an MT quality assessment yardstick, has been researched several times so far; however, its inherent relativity fits the concept of translation efficacy. That is, an MT output has efficacy as far as it is 'desirable' or 'good' enough for users to meet their specific reading purposes. The present study confirmed the fact that the efficacy of MT output is target-reader-dependent and text-dependent since it is determined both by the characteristics of the readers, such as their disciplines, and text features, as demonstrated by the significant differences in comprehension levels of the same readers measured by the same questions for HT and MT output. Accordingly, this study shed limelight on comprehensibility as a criterion of MT output efficacy; that is to say, it has to be reminded that MT quality needs to be defined as a context-bound and target-reader-specific concept.

The findings of this study feature some implications for MT users in academic contexts and ESP courses. Considering the user-dependency of MT, its end-users have to be born in mind and their characteristics such as strategic competence and background knowledge have been taken into account. In addition, it has to be remembered that with regard to text-dependency of the quality of MT output, its users have to notice the text type, content, genre before counting on an MT system since a given MT system may be suitable for translating a specific genre or content from a specific subject area, but not a different genre or content from another field of study. In addition, there is a need to consider MT literacy [58] by students and teachers. If MT is to be

widely used in English teaching courses, both teachers and students will ideally need some degree of MT literacy [59].

It is undeniable that the findings of the study have to be interpreted with caution since the number of participants in this study was low, and despite the reliability of the test, the number of reading comprehension sub-skills, items, and texts was not many. The next steps are to replicate this study with other languages than English as well as invite more participants. Further consideration may include texts of different genres and content.

Authors' Contribution

Both authors were equally involved in conducting the study, analyzing the data, and writing the paper.

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Conflicts of Interest

The authors have no conflict of interest.

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AUTHOR(S) BIOSKETCHES

Vahid R. Mirzaeian has got a PhD. in CALL from the University of Manchester. He is currently working on CALL-related issues.

Mirzaeian, V. Associate Professor, Applied and Computational Linguistics, Alzahra University, Tehran, Iran

mirzaeian@alzahra.ac.ir

Mojtaba Maghsudy got his PhD. from Puna University in India. He is currently an academic member of staff at Farhangian University working on areas related to foreign language learning.

Maghsoudi, M. Associate Professor, Department of English Language Teaching, Farhangian University, Tehran, Iran

Maghsduim@cfu.ac.ir

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ORIGINAL RESEARCH PAPER

Online vs. offline Problem-based Learning Affecting Foreign Language Learners' willingness to communicate, self-efficacy, and classroom anxiety

S. Moslemi Nezhad Arani[1], A. A. Zarei[*,1], A. Sarani[2]*

[1] *Department of English Language Teaching, Imam Khomeini International University, Qazvin, Iran*
[2] *Department of English Language and Literature, University of Sistan and Baluchestan, Zahedan, Iran*

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* Corresponding author
a.zarei@hum.ikiu.ac.ir
(+9828) 33901621

ABSTRACT

Background and Objectives: The essence of Problem-based Learning (PBL) is to find a prêt-à-porter solution to a problem, which is also known as scenario. Several features differentiate this teaching methodology from other typical approaches in language teaching contexts. In order to reinforce the association between learners' construction of the required knowledge to solve an ill-structured problem when assessing different possible solutions and attempting to find an acceptable solution, learners need to collect necessary information mostly on their own with the help of a teacher as a facilitator. PBL can also be considered as a potentially useful approach to language teaching and learning, especially with regard to productive skills in which leaners practice more fluently if they experience more involvement in the learning process. The PBL also contributes to learners and learning psychological aspects. Despite the generally acknowledged benefits of PBL, it has not been commonly used, especially in foreign language learning contexts. One reason for this may have been concerns about how the method might affect foreign language learners' feeling of anxiety, self-efficacy and willingness to communicate. The major objective of this study was to bridge the gap in our understanding of how the implementation of the PBL approach affects English as a Foreign Language (EFL) learners' psychological factors of willingness to communicate, self-efficacy, and classroom anxiety.

Materials and Methods: Ninety pre-intermediate EFL students were selected according to the Oxford Placement Test (OPT) and purposeful sampling method. They were randomly assigned into 3 groups of online PBL, face-to-face PBL, and control group with 30 learners in each. Students in both online PBL and face-to-face PBL classes embarked on a 10-session speaking course according to the framework of the PBL approach. Meanwhile, the control group received speaking instruction based on a conventional method other than the PBL. Three questionnaires of Willingness to Communicate (WTC), English self-efficacy, and foreign language classroom anxiety scale were administered before and after the course to all participants. Analysis of covariance (ANCOVA) was employed to analyze the data.

Findings: Results showed that EFL learners in the online and face-to-face PBL classes outperformed those in the control group in their WTC and self-efficacy. In addition, learners in the online and face-to-face PBL groups meaningfully experienced a lower level of classroom anxiety compared with the control group.

Conclusions: The findings of the present study suggest that the PBL approach efficiently motivates learners to communicate and interact within the classroom context. In addition, learners in the online and conventional PBL groups felt more self-determining and responsible for their learning as a result of feeling more comfortable in the learning environment. Results also shed light on the idea that due to the experiential aspect of PBL, when learners explore the solutions to the problem/scenario and discuss them with others, that forms an environment with a minimized classroom speaking anxiety. Implications are also discussed at the end of the study.

NUMBER OF REFERENCES	NUMBER OF FIGURES	NUMBER OF TABLES
56	0	9

مقاله پژوهشی

تاثیر یادگیری مبتنی بر مسئله برخط و حضوری بر تمایل زبان آموزان به برقراری ارتباط، احساس خودکارآمدی، و اضطراب کلاس درس

سعید مسلمی نژاد آرانی[1]، عباسعلی زارعی موینی*[1]، عبدالله سارانی[2]

[1] گروه آموزش زبان انگلیسی، دانشکده ادبیات و علوم انسانی، دانشگاه بین‌المللی امام خمینی (ره)، قزوین، ایران

[2] گروه آموزش زبان انگلیسی، دانشکده ادبیات و علوم انسانی، دانشگاه سیستان و بلوچستان، زاهدان، ایران

چکیده

پیشینه و اهداف: یکی از ملاحظات اساسی در یادگیری مبتنی بر مسئله عدم وجود یک راه حل واحد برای پاسخگویی به مسئله است که البته در آموزش زبان به آن سناریو نیز گفته می‌شود. با این‌حال، شیوه یادگیری مبتنی بر حل مسئله دارای ویژگی‌های دیگری نیز می‌باشد که آن را از دیگر شیوه‌های مرسوم یادگیری زبان متمایز می‌سازد. در این شیوه، به منظور برقراری ارتباط پایدار و معنی‌دار میان کسب دانش لازم برای پاسخگویی به مسئله از طریق کشف و بررسی راه حل‌های ممکن و انتخاب مناسب‌ترین راه حل، لازم است تا زبان‌آموز صرفا از طریف خود اکتشافی به بررسی و ارزیابی اطلاعات لازم برای پاسخ به مسئله بپردازد. البته، معلم، صرفا در نقش تسهیل‌گر ظاهر شده و در صورت لزوم زبان آموزان را راهنمایی می‌کند. این شیوه از یادگیری می‌تواند دررابطه با مهارت‌های تولیدی زبان‌آموزان بسیار موثر باشد، چرا که آن‌ها در صورت مشارکت در فرایند یادگیری- آن چه که این شیوه بر آن تاکید میکند - شیوایی کلام بهتری را تجربه می‌کنند. بدین‌ترتیب می‌توان گفت که این شیوه از آموزش صفات روانشناختی فراگیران را نیز تحت تاثیر قرار می‌دهد. از این‌رو، مطالعه حاضر خلاء تحقیقاتی در مورد کاربرد شیوه مسئله محور و تاثیر آن بر عوامل روانشناختی از قبیل تمایل به برقراری ارتباط، خودکارامدی، و اضطراب کلاس درس می‌پردازد.

روش‌ها: تعداد ۹۰ نفر از زبان آموزان سطح پیش متوسط زبان انگلیسی بر مبنای آزمون تعیین سطح آکسفورد و روش نمونه گیری هدفمند انتخاب شدند. افراد مورد نظر، به صورت تصادفی در سه گروه ۳۰ نفره (۱) گروه شیوه مبتنی بر مسئله برخط، (۲) گروه شیوه مبتنی بر مسئله حضوری، و (۳) گروه کنترل با شیوه تدریس غیر از یادگیری مبتنی بر مسئله تقسیم بندی شدند. زبان آموزان در هر سه گروه فوق در یک دوره ۱۰ جلسه‌ای آموزش مهارت گفتاری شرکت کردند. سه پرسشنامه تمایل به برقراری ارتباط، خودکارآمدی، و اضطرب در کلاس زبان در ابتدا و پایان دوره توسط زبان آموزان پاسخ داده شدند. برای تجزیه و تحلیل داده های جمع آوری شده از پرسشنامه ها از تحلیل کواریانس (انکووا) استفاده شد.

یافته‌ها: نتایج نشان داد که کاربرد شیوه مبتنی بر مسئله در کلاس برخط به طور قابل توجهی موثرتر از شیوه مبتنی بر مسئله در کلاس حضوری بوده است. یافته ها همچنین نشان داد که فراگیران زبان انگلیسی در کلاس‌های برخط و حضوری با بکارگیری شیوه مبتنی بر مسئله نسبت به زبان آموزان گروه کنترل در زمینه تمایل به برقراری ارتباط عملکرد بهتری داشتند. علاوه بر این، زبان آموزان در گروه های آموزش مبتنی بر مسئله برخط و حضوری به طور معناداری سطح پایین‌تری از اضطراب کلاس درس را در مقایسه با گروه کنترل تجربه کردند.

نتیجه‌گیری: بر اساس یافته های مطالعه حاضر می‌توان چنین استنباط کرد که شیوه مبتنی بر حل مسئله در ایجاد انگیزه در زبان آموزان در جهت ایجاد ارتباط کلامی در زبان مقصد موثر است. علاوه براین، زبان آموزانی که در کلاس‌های برخط تحت تاثیر این شوه قرار می‌گیرند، حس مسئولیت بیشتری را نسبت به یادگیری خود پیدا می‌کنند و در نتیجه احساس خوشنودی بیشتری را نیز تجربه می‌کنند. از سویی دیگر، به‌دلیل خود اکتشافی بودن این شیوه بویژه زمانی که زبان آموز به کشف راه حل پرداخته و آن را با هم کلاسی‌های خود مورد بحث قرار می‌دهد، اضطراب بسیار کمتری را تجربه کرده که به فرایند یادگیری کمک می‌کند. کاربردهای استفاده از نتایج این مطالعه در پایان مورد بررسی و پیشنهاد قرار گرفته است.

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* نویسنده مسئول
a.zarei@hum.ikiu.ac.ir
۰۲۸ -۳۳۹۰۱۶۲۱

Introduction

The twentieth century is characterized by a radical shift in teaching methodologies as a result of the emergence of constructivist ideas [1]. The constructivist perspective to learning is built upon the active construction of knowledge by learners and was an attempt to dethrone the reductionist behavioral approaches to learning. Drawing on the tenets of constructivism, PBL is one of the latest trends in teaching EFL [2]. In PBL, problems play a central role for which learners have to work, in groups or individually, to find solutions. Another central concept in this regard is collaboration since emphasis is placed on group work and the construction of possible solutions. This collaborative aspect, along with the authentic nature of the problems proposed to students can prove beneficial in developing learners' communicative skills [3].

Accordingly, learners first think of a plan to solve the problem, and during their planning, they identify the necessary changes, possibilities, and procedures to synthesize a solution to the problem. This helps students in the subsequent levels where a more profound understanding is required, that is, the analysis of the problem. Then, depending on the nature of the problem, learners in their group create new ideas generated from the already discussed ones, segmentize and unify the components, and categorize the patterns in predicting the possible outcomes of the solution [4]. Finally, learners try to apply what they have learned, especially in other situations, to see if they can make use of their solutions on different occasions.

Given that possible answers to problems are formed learners' minds, according to their understanding of the problem, PBL can be considered as a salient instance of constructivism. Since there are no pre-defined solutions to the problem at hand, possible answers may vary between groups and individuals; therefore, answers are all considered acceptable as long as the problem is solved [5]. Learners' construction of required knowledge for solving the problem, trying different possible solutions, and struggling with ill-structured problems to reach an acceptable solution is primarily linked to the constructivist philosophy of learning. It can also be considered as a potentially useful approach to language teaching and learning, especially with regard to productive skills. It can improve learners' WTC [6] and self-efficacy target language use [7]. Furthermore, PBL can help learners overcome their classroom anxiety [8].

The present study seeks to investigate the effects of the PBL approach on EFL learners' psychological factors of WTC, self-efficacy, and classroom anxiety. The effects of various variables on promoting language learners' WTC [9, 10, 11, 12], and self-efficacy [13, 14] have been studied in the literature. However, fewer attempts have been made to implement PBL to facilitate EFL learners' WTC and self-efficacy. Since the PBL approach considers learning through interpersonal interaction [15], it can be beneficial for maximizing learners' WTC in the classroom context.

Furthermore, given the hindering effect of anxiety on students' classroom performance [16, 17, 18, 19], it is of great importance to find ways to minimize students' anxiety. One potential solution is to make learners participate more in classroom activities [20]. Since active participation and collaboration are essential characteristics of the PBL approach, this teaching method can effectively minimize learners' classroom anxiety [21]. Accordingly, it is necessary to evaluate the effects of the PBL approach on reducing classroom anxiety in different contexts to help learners experience effective learning. Equally important, given the rise of online learning and teaching, the

importance of shedding light on the application of PBL in an online context cannot be emphasized enough. In an attempt to address these issues, this study attempts to answer these questions:

- Are there any significant differences among the effects of online PBL, face-to-face PBL and conventional instruction on EFL learners' WTC?
- Are there any significant differences among the effects of online PBL, face-to-face PBL and conventional instruction on EFL learners' self-efficacy?
- Are there any significant differences among the effects of online PBL, face-to-face PBL and conventional instruction on EFL learners' level of speaking anxiety?

Review of the Related Literature

Problem-based Learning

At the time of rapid change, one of the most important skills that learners should be equipped with is problem-solving [22]. Dating back to the 1970s, PBL rose against a lecture-based model of teaching where feeding ideas to students formed the central concept of teaching [23]. The traditional transmissionist approach to teaching in which the teacher is the only source of information and tries to transfer chunks of information to students, who must memorize them with little/no cognitive involvement in the process of learning, creates additional problems in learning such as lack of necessary experience and the low rate of knowledge retention [24]. That is, lecture-based teaching does not deliver practical experience and may not lead to optimum learning [4]. As a reaction to such problems, PBL is a student-centered approach that encourages students to resort to their research abilities, collaborate, and draw on their creativity and other cognitive repertoire to come up with a viable solution to an ill-defined problem [23].

Before proceeding any further, it would not be amiss to contextualize the notion of 'problem' within PBL. A problem can serve as a strong stimulus in convincing learners to work together and draw on the collective resources of the group to solve the problem [25]. The nature of the problem is also of great importance and it is not to be confused with such concepts as 'puzzle'. The main difference between 'problem' and 'puzzle' is that the former is *intended* to be ill-formed for which learners can find a multitude of solutions. On the other hand, puzzles are well-formed, and there is only one possible solution to them [26]. The multiplicity of problems is of great importance since it can drive learners' creativity and their reliance on the collective resources of the group to find any possible solution to the problem at hand. PBL is characterized by authenticity since learners deal with real-life problems [27]. The high level of cognitive engagement can be a trump card for galvanizing learners' critical thinking skills [28].

The ill-structured nature of problems, on the one hand, and the collaborative nature of the work, on the other, give way to a large number of solutions in the learning context. As a result of this diversity, a number of PBL models have been created, integrating the characteristics and objectives of PBL into a unified whole [3]. However, the multitude of existing PBL models has paved the way for the misapplication of the method. Many studies in the field of language pedagogy have faltered in the correct implementation of the model. Since PBL has been applied in different disciplines, a version of PBL tailored to language learning classes should be of the highest order since learning does not occur identically [5]. Moreover, even when PBL is designed specifically for the purpose of language

teaching, it is unclear how it might affect learners' affective variables. This study in intended to address this issue.

Affective Variables

Willingness to communicate (WTC) refers to individuals' intention to communicate [29]. This aspect of communication is highly affected by individuals' characteristics, especially the desire to initiate communication. In language learning, learners bring to class characteristics that might be influential in their language learning achievement. One of these characteristics is WTC. According to [29], WTC has been more influential in communication than other variables such as anxiety or communicative competence. WTC has been shown to be the prediction of communication initiation both in L2 and L1 [30].

Self-efficacy is a self-judgment that one may make to see how much s/he can perform a domain-specific task [31]. Self-efficacy partakes a mutual relationship with one's performance in which a high degree of self-efficacy positively affects one's performance on a specific task, and this good performance will, in turn, enhance self-efficacy [32]. Accordingly, it is believed that self-efficacy can affect the factors that predict motivation.

PBL provides learners with the opportunity to direct their own learning. This self-directedness, as one of the components of PBL, can be achieved when learners have higher self-efficacy [33]. According to [34], learners who experience PBL courses gain more self-sufficiency since they are in charge of their own learning. The possible relationship between PBL and learners' self-efficacy reinforces [35]'s idea that PBL can develop learners' competence and creativity in new problem-solving activities where they can think critically to adopt suitable solutions.

Anxiety refers to an individual's feeling of tension, nervousness, apprehension, and worry due to stimulation of the autonomic nervous system [36]. Horwitz [37] argued that the notion of anxiety is a multi-dimensional concept; psychologists have identified different types of anxiety including trait anxiety, achievement anxiety, facilitative-debilitative anxiety, state anxiety, and achievement anxiety. In the late 1980s, the concept of anxiety was seriously inspected in language teaching after the work of [36], who introduced Foreign Language Anxiety (FLA). MacIntyre et al.'s [38] definition of FLA refers to the state of worry or negative feelings learners develop towards learning a foreign language. Horwitz et al.'s [39] definition of FLA still seems a comprehensive description that FLA includes one's feelings, beliefs, and behaviors resulting from learning and using foreign languages. Accordingly, the performance of foreign language learners can be highly negatively affected by the stress of classroom situations. There are some affective psychological variables like motivation, attitudes, self-confidence, and anxiety that possibly create or intensify difficulties in language learning. As Toyama and Yamazaki [40] concluded, FLA is seen as an affective filter in foreign language learning contexts.

A number of studies have been conducted on the implementation of the PBL approach in language learning classes and its possible effect on learners' engagement and willingness to communicate [41, 42, 43, 44, 45]. In addition to reporting a significant improvement in learners' oral communication, the above-mentioned studies reported a significantly higher engagement of students in the PBL classes compared to lecture-based ones. The researchers also noted that not only does PBL allow learners to be more willing to communicate when using the target language

verbally, but it also helps improve learners' oral communication ability. Since PBL triggers EFL learners' critical thinking, particularly when students explore the possible answers to the problem/scenario, it leads to more WTC [44].

As another variable considered in this study, self-efficacy has always been evaluated by researchers in the area of PBL. The PBL approach develops thinking and problem-solving skills and helps learners to become self-sufficient in their problem-solving tasks [46]. In other words, PBL provides the opportunity for students to achieve a cognitive skill, in general, and cultivates learners' sense of self-efficacy, in particular [8]. According to Dunlap [7], since PBL is a practice for real-life problem-solving activities, providing students with the possibility of obtaining the required skills and knowledge in their future profession, it considers students' self-efficacy fundamental for their performance. This concept is also reinforced by Maulidia et al. [47] and Risnawati et al. [48], believing that PBL improves learners' creative thinking and improves their self-efficacy. Learners' improved self-efficacy is due to the PBL nature, which provides students with a sense of responsibility for their own learning, an in-depth understanding of the materials, and the proximity of the application of PBL with their future needs and professional life. Indeed, PBL allows learners to be self-directed in their learning and makes them feel more self-efficacious concerning problem-solving activities [49]. Altogether, PBL provides students with a sense of autonomy and makes them responsible for their learning [34]. In conclusion, studies indicate that PBL is advantageous in refining learners' self-efficacy targeting students' learning and practicing social skills.

In terms of classroom anxiety, several studies have examined classroom speaking anxiety in the PBL context. As Toyama and Yamazaki [40] argued, since learners in PBL classes have more engagement while finding answers to the problem and working with the materials, they experience less speaking anxiety than students attending conventional classes. The PBL approach is helpful in minimizing learners' speaking anxiety [21]. The effectiveness of PBL on classroom anxiety was also reported by Babaee and Borji [50] in a writing course. They reported that not only did EFL learners' writing anxiety decrease in the PBL group, but the EFL learners also outperformed the control group in writing. Pinter [51] examined the effects of PBL instruction on math students' anxiety. The researcher concluded that PBL significantly reduces learners' classroom anxiety. However, Jatisunda et al. [20] reported that PBL negatively influences students' level of anxiety. They claimed that using PBL to offer problem-solving tasks provides students with mathematics anxiety, which prevents them from showing optimum performance in solving problems.

Since PBL is still in its trial and error stage in language teaching [5], not only can this approach provide us with valuable feedback regarding its effects in different contexts, but also investigating the effects of such an approach on learners' psychometric characteristics can best help the improvement of PBL in line with the developments in language learning contexts. This suggests that studying the positive or negative effects of PBL is only obliging when we consider the role of contexts and learners. It is what most of the studies mentioned above lack. These studies merely administered the same PBL methodology borrowed from other fields, e.g., medicine, engineering, etc., and practiced it in language teaching contexts to measure learners' affective filters while working with PBL. Although they have reported the positive effects of PBL on learners' psychometrics

variables, the gap remains untouched about employing a model of PBL developed and tuned for teaching a language in EFL contexts. To fill this gap, this study attempted to employ a model of PBL specific for language teaching classes to check its effect on the mentioned psychological variables.

Method

Participants

A public announcement was made for a free speaking course lasting for ten sessions, and 140 Iranian EFL learners registered for the course. The announcement was made through an English language institute in Zahedan, Iran. To prevent the possibility of language proficiency influencing the selected variables, only the applicants with pre-intermediate level of language proficiency were of interest. To determine the applicants' level of language proficiency, Oxford Placement Test (OPT) was administered. The target score range for the applicants to be included in the study was 120 to 135. Upon screening, 90 participants remained who were randomly assigned to three different classes (with 30 learners each): face-to-face PBL speaking class, online PBL speaking class, and a control group. The participants included both male and female learners with an age range of 21 to 39.

Instruments

The utilized instruments and materials for this research were as follows:

Placement Test

The OPT was used to determine the applicants' level of English proficiency. The main reasons for the selection of this test were availability and practicality. It is a 200-item multiple-choice test providing an exact yardstick through which English language proficiency level can be ascertained in relation to the Common European Framework of Reference (CEFR). The test is composed of two sections: (1) language use, and (2) listening. The first section is comprised of 100 multiple-choice items, focusing on knowledge of grammar and vocabulary. The response time for this section is 50 minutes. The second section, consisting in 100 multiple-choice items, is concerned with test takers' listening abilities. Since OPT is internationally renowned and has already been widely used in multiple studies for the same purpose, its validity was taken for granted. Its reliability coefficient was calculated via the KR-21 to be 0.85.

Web-based Platform

Zoom, a cloud-based online platform offering video conferencing services and online classes, was used to offer the online PBL class. This online teaching platform makes it possible to hold one-to-one and group meetings in an online environment. An invitation link was shared with the learners by the instructor. The participants could easily chat or talk with each other in the class. The rationale behind the usage of this platform was that it could provide the necessary environment to run a PBL language class, one in which collaboration between students could be realized.

The WTC Questionnaire

The WTC questionnaire [30] was used to measure learners' WTC. The questionnaire included 27 items that were categorized into four sections according to each of the language skills concerning the learners' feelings about communication with others in the classroom. In this scale, for each item, learners indicated their WTC through a five-level Likert-type scale which ranged from 1 (almost never willing) to 5 (almost always willing). Cronbach's alpha reliability indices for the pretest and post-test

of WTC were (α = 0.965), and (α = 0.969), respectively.

English Self-efficacy Questionnaire

The learners' self-efficacy was measured using Wang's questionnaire of English self-efficacy. The questionnaire included 32 items on a 7-point Likert-type scale which ranged from (not at all confident = 1) to (extremely confident = 7). This scale measures the English self-efficacy of EFL learners in all the four skills; it has seven items of listening, six items of speaking, six items of reading, and five items of writing. On this scale, higher scores mean higher levels of self-efficacy. The Cronbach's alpha reliability indices for the pretest and post-test of self-efficacy were (α = 0.924) and (α = 0.971), respectively. Their validity was based on the validity reported by Fahmi et al. [54] and Sutrisna and Artini [55]. To check the content validity of the questionnaire, it was submitted to two TEFL university professors as experts, and they confirmed its validity prior to administration.

The Foreign Language Classroom Anxiety Scale

The Foreign Language Classroom Anxiety Scale (FLCAS) [36] was administered for measuring students' level of anxiety. The questionnaire is composed of 33 statements that require students to rate themselves based on a 5-point Likert-type scale ranging from 1 (strongly agree) to 5 (strongly disagree). The reliability of the scale was estimated in the context of this study using Cronbach's alpha. The reliability indices were 0.961 for the pretest and 0.945 for the post-test of FLCAS.

Procedure

After the participants were selected and assigned to the treatment groups, the PBL model proposed by [5] was utilized to offer speaking lessons to students in the two experimental groups. In the first session, the learners were informed about the method of teaching. Due to the Coronavirus pandemic, it was not possible to run a face-to-face class with 30 EFL learners simultaneously. Therefore, the class was divided into two classes of 15 students, and each class was divided into 2 or 3-member groups. However, in the online class, all the 30 students could attend the class together; therefore, they were divided into six groups of five members.

A topic in the form of a problem was introduced to the class at the beginning of each session. The problem was presented in the form of a scenario. The scenario was introduced by the teacher reading and explaining it in the class. The teacher then asked the students to imagine themselves in a context introduced by the problem and think about possible solutions to the scenario. The teacher helped the students about how to create some related questions about the problem. Meanwhile, the students were also notified about the available helpful resources for answering the problem. Groups were asked to record a list of resources and vocabulary items they employed while working on the problem. Then, the groups were provided with time to compile their possible solutions. The allocated time for both face-to-face and online PBL classes was 40 minutes. The teacher questioned the students to rationalize their answers by asking themselves the question 'Why is this the possible solution to the problem?'

Next, the students used the target language to talk about their understandings. In the face-to-face PBL class, the teacher observed the students by walking around the class and providing comments, if necessary. The students were also allowed to ask for the teacher's help when required. In the online PBL class, a similar procedure was followed. When the students came up with their final solutions to the problem, each group was asked to share the

solution. For the online PBL class, when the time was over, all groups were closed and all the students were sent to the meeting room.

The students were asked to comment on the suggested solutions and offer their feedback. They were also asked to take notes regarding the feedback they received concerning their solutions. After applying the applicable feedback, the final solutions were presented. The students were asked to discuss the reasons for their (dis)agreements with the suggestions they received. At the end of the session, the students selected one or more solutions as the best one(s) with the help of the teacher.

In the control group, 30 participants were randomly assigned to speaking courses offered on the basis of Top Notch book series [52]. Since their proficiency level was pre-intermediate, Top Notch 1A textbook was used as the course material. In this group, no group assignments and no problems or scenarios were used. Lesson plans were developed for all the ten lessons to be taught. At the start of each lesson, the grammar and vocabulary points that students would study through the lesson were presented. This was to be complemented with the corresponding exercises in the workbook which students had to complete on their own. The new vocabulary items were written on the whiteboard, and the students were asked to provide English definitions and synonyms for the presented words. This took around 10-15 minutes; the teacher tried to encourage the students to participate more in the class by asking questions such as 'What does it mean?', 'What is the synonym for that word?', etc.

Next, the teacher engaged students' in Photo Story and short conversations. The students were asked to discuss their understanding of the conversation. Then, the students were asked to close their books and listen to the short conversations. In this stage, some questions were written on the board which the students were asked to answer. Using the presented speaking strategies, the students were asked to (dis)agree with the answers of other students. The same procedure was followed in the reading section of each lesson. Before each reading section, the unfamiliar words were worked on by asking students to review and scan the passage. The students were asked to speak about their understanding of the text. Then, the questions following each reading passage were answered. Throughout the class, the teacher provided corrective feedback on students' use of grammar and vocabulary. The class was concluded with the assignment of homework to students.

In the beginning and at the end of the course (after 10 sessions of instruction), an online version of each of the questionnaires was developed and presented to the participants in all the three groups. The collected data were analyzed using three separate one-way ANCOVA procedures to see if there were any significant differences among the online PBL, conventional PBL, and control groups in terms of their WTC, self-efficacy, and FLCAS.

Design

Problem-based learning was the independent variable and willingness to communicate, self-efficacy and classroom anxiety were the three dependent variables of the study. Almost all the conditions of true-experimental designs were met. However, although the assignment of each group of participants to different treatment conditions was done randomly, the initial selection of the participants was not done on a random basis. Therefore, the design of the study was quasi-experimental.

Results and Findings

The present study aimed at investigating the effects of face-to-face and online PBL on EFL

learners' psychological factors of willingness to communicate, self-efficacy, and classroom anxiety. To address each of these questions, a one-way Analysis of Covariance (ANCOVA) was used. Before using ANCOVA, its assumptions were checked, and there were no violations.

Results on WTC

The first research question compared online PBL, face-to-face PBL and conventional instruction groups in terms of EFL learners' WTC. Descriptive statistics for pre-and posttests of WTC are presented in Table 1.

Table 2 shows the main results of one-way ANCOVA. The results ($F_{(2, 86)} = 15.35$, $p < .01$, partial eta squared = .263, representing a large effect size) indicated that there were significant differences between the three groups' means on post-test of WTC after controlling for the effect of the pretest.

The significant results were followed by post-hoc comparison tests (Table 3) to compare the groups in pairs.

Based on these results, it can be concluded that:

A) The online PBL group significantly outperformed the face-to-face PBL group) on the post-test of WTC ($p < .01$).

B) The online PBL group (M = 86.96) significantly outperformed the control group on the post-test of WTC after controlling for the effect of the pretest ($p < .01$).

C) The face-to-face PBL group significantly outperformed the control group on the post-test of WTC ($p < .01$).

Table 1: Descriptive Statistics for Willingness to Communicate

Test	Group	N	PretestMean scores	Posttest Mean scores
Pretest	Online PBL	30	63.93	88.57
	Face-to-face PBL	30	64.37	77.20
	Control	30	57.03	59.17

Table 2: Tests of Between-Subjects Effects on WTC

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Pretest	28402.725	1	28402.725	100.200	.000	.538
Group	8706.920	2	4353.460	15.358	.000	.263
Error	24377.608	86	283.461			
Total	571918.000	90				

Table 3: Post-hoc Comparisons on WTC

(I) Group	(J) Group	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval for Difference	
					Lower Bound	Upper Bound
Online	Face-to-face	11.690*	4.347	.026	1.075	22.304
	Control	24.259*	4.377	.000	13.570	34.947
Face-to-face	Control	12.569*	4.381	.016	1.871	23.267

*. The mean difference is significant at the .05 level.

Results on Self-efficacy

The second research question investigated the effects of online PBL, face-to-face PBL, and conventional instruction on self-efficacy. A one-way ANCOVA was used to address this question. Descriptive statistics are presented in Table 4.

As seen in Table 5, the online PBL group had the highest mean score on the post-test of self-efficacy. This was followed by the face-to-face PBL and control groups. One-way ANCOVA results ($F_{(2, 86)} = 37.64$, $p < .05$, partial eta squared = .467, representing a large effect size) indicated significant differences among the three groups' mean scores on the post-test of self-efficacy.

Pairwise comparisons (Table 6) suggested that, the online PBL group significantly outperformed the face-to-face PBL group on the post-test of self-efficacy. Moreover, the online PBL group significantly outperformed the control group. Meanwhile, the face-to-face PBL group significantly outperformed the control group.

Results on Classroom Anxiety

The third research question explored the differences among the online PBL, face-to-face PBL, and conventional instruction groups in terms of classroom anxiety. A one-way ANCOVA was used to answer this question. Table 7 summarizes the descriptive statistics.

The main results of one-way ANCOVA (Table 8) suggested significant differences among the three groups' means on the post-test of classroom anxiety ($F_{(2, 86)} = 16.68$, $p < .01$, partial eta squared = .280, representing a large effect size).

Post-hoc comparison tests (Table 9) indicated that all three comparisons resulted in significant paired differences with the control showing the highest level of classroom anxiety and the online PBL the lowest.

Table 4: Descriptive Statistics for Self-efficacy

Test	Group	N	Pretest Mean Scores	Posttest Mean Scores
Pretest	Online PBL	30	89.30	123.17
	Face-to-face PBL	30	80.83	86.93
	Control	30	81.10	70.53

Table 5: Tests of between-Subjects Effects on Self-efficacy

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Pretest	27409.449	1	27409.449	64.937	.000	.430
Group	31782.874	2	15891.437	37.649	.000	.467
Error	36300.051	86	422.094			
Total	894781.000	90				

Table 6: Post-Hoc Comparisons on Self-Efficacy

(I) Group	(J) Group	Mean Difference (I-J)	Sig.	95% Confidence Interval for Difference	
				Lower Bound	Upper Bound
Online	Face-to-face	29.456*	.000	16.342	42.570
	Control	46.070*	.000	32.965	59.174
Face-to-face	Control	16.613*	.007	3.661	29.566

Table 7: Descriptive Statistics on Classroom Speaking Anxiety

Test	Group	N	Pretest Mean Scores	Posttest Mean Scores
Pretest	Online PBL	30	92.07	70.43
	Face-to-face PBL	30	86.40	79.50
	Control	30	85.70	90.90

Table 8: Tests of between-Subjects Effects on Classroom Speaking Anxiety

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Pretest	9443.395	1	9443.395	39.462	.000	.315
Group	7984.219	2	3992.110	16.682	.000	.280
Error	20580.172	86	239.304			
Total	616341.000	90				

Table 9: Post-hoc Comparisons on Classroom Speaking Anxiety

(I) Group	(J) Group	Mean Difference (I-J)	Sig.	95% Confidence Interval for Difference	
				Lower Bound	Upper Bound
Control	Online	23.207*	.000	13.397	33.018
	Face-to-face	11.701*	.013	1.948	21.455
Face-to-face	Online	11.506*	.016	1.707	21.305

Discussion

The present study sought to investigate the effects of the PBL approach on EFL learners' WTC, self-efficacy, and classroom speaking anxiety. It was found that the EFL learners who participated in online and conventional PBL groups showed a higher rate of engagement in the classes compared to the control group. The results of the WTC questionnaire showed that learners in the PBL groups were more willing to communicate in class. This finding seems to be in line with the works of Delialioğlu [41], Lin [42], Mandeville et al. [43], (Sellnow and Ahlfeldt [45], and Yaghoubi [44].

According to Delialioğlu [41], the high rate of learners' engagement in the PBL class is because of an active learning environment created by PBL. This statement is in line with the teacher's observation in this study indicating the active participation of the learners in PBL classes, especially for the online PBL group. Mandeville et al. [43] argue that students' high rate of WTC is primarily due to the nature of PBL, which makes learners more interested in verbally communicating with others through the application of target objectives. More comparable to the present research is the study conducted by Lin [42], who observed the effectiveness of PBL in promoting learners' rate of engagement in the class.

The results of the present study in terms of the students' level of WTC also support the result reported by Yaghoubi [44]. He asserted that since the application of the PBL approach provides EFL learners with better critical thinking ability, it leads to the learners' higher level of engagement in the PBL classes. The higher rate of WTC originate from the learners' exploration and preparation of the possible answers to problems in PBL classes, particularly when solutions are supposed to be presented and discussed orally [45].

It was also found that the learners who participated in the two PBL classes were more self-efficacious than those in the control group.

The students' self-efficacy in the online PBL group exceeded that of both the face-to-face PBL and control groups. According to the findings, PBL creates a learning context where learners can develop their thinking and problem-solving skills. The implementation of PBL makes students ready to employ self-regulated skills. It provides the students with a sense of self-efficacy in applying cognitive skills when challenging the proposed problem/scenarios [8]. Generally, the results of the self-efficacy questionnaire in the present research are mostly in line with other similar studies [7, 34, 47, 48].

The learners' higher level of self-efficacy is possibly due to the sense of autonomy resulting from the application of PBL. Mataka and Kowalske [34] concluded that the learners who attended PBL classes showed a higher level of self-efficacy, not just because they experienced learning by themselves but also because PBL made them more responsible for their learning and, as a result, autonomous learners. As discussed previously, the students in the online PBL group were more self-efficacious than those in the face-to-face PBL group. This result reinforces the findings of Alfares [53], who reported that the application of PBL accompanied by online learning platforms significantly affects learners' problem-solving self-efficacy. Online PBL classes benefit learners' learning and improve their social skills. On the other hand, although different researchers have reported the effectiveness of the PBL approach on students' self-efficacy, Fesharaki et al. [54] claimed that any level of gained self-efficacy could possibly be due to the effective nature of education, not the employed methods such as PBL.

It was also revealed that PBL increased students' level of self-efficacy. This is possibly due to the fact that PBL creates situations similar to real-life contexts where students obtain the required skills and knowledge that they need in their target situations [7]. Accordingly, PBL helps learners keep their learning aligned with their learning objectives. Risnawati et al. [48] hold that students' high level of self-efficacy in PBL classes is because PBL provides learners with creative thinking ability and a higher sense of self-efficacy. Additionally, Quang et al. [33] argue that the increased level of self-efficacy is due to the nature of PBL, which maximizes learners' sense of responsibility for their learning about what to learn and why to learn; this is directly influenced by their future needs and professional life.

As Maulidia et al. [47] pointed out, there is a direct relationship between students' self-efficacy and their creativity. This observation is also corroborated by the results of the present study. One of the researchers of this study who was in charge of offering the PBL classes, according to his observation, reported a considerable level of creativity shown by the learners in the PBL classes. The teacher believed that learners in both online and face-to-face PBL classes followed the teacher's instructions to use the resources to find the possible solution to the scenarios. They also attempted other new ways and resources as they asked for the teacher's confirmation of the usefulness of the recommended alternatives. It could be argued that learners in the PBL groups, more noticeably in the online PBL group, applied their own creativity and confidence in solving the scenarios as a result of the higher level of self-efficacy compared with the control group.

The findings of the present study also showed that the implementation of PBL could positively influence learners' classroom anxiety. According to the results, learners in the control group had the highest level of classroom anxiety. Learners in the online PBL group had the lowest classroom anxiety level compared to

the face-to-face PBL and the control group. This improvement in the level of students' anxiety is in line with other similar studies [21, 50]. (Fahmi et al. [55] believe that since learners in PBL are provided with more in-group or in-person engagement to find possible answers to problems/scenarios, they experience less speaking and classroom anxiety. This claim is possibly due to the fact that students' collaboration, particularly their in-group discussion, provides them with a better readiness when they want to talk in public or in a class. Therefore, measures must be taken to minimize speaking and classroom anxiety. (Sutrisna and Artini [56] state that PBL instruction is beneficial to classroom anxiety reduction, and as a result, it helps learners to experience less anxiety in their speaking even out of the classroom. It is also believed that students in PBL classes directly and practically learn their needs in the prospective target situations [50]. This approach helps students to become more self-confident and confront target situations with a lower level of anxiety. In fact, learners attending PBL courses experience a lower level of anxiety and feel more self-efficacious.

Although the effectiveness of PBL instruction on reducing the level of anxiety was shown in this study and other studies mentioned earlier, (Jatisunda et al. [20] reported a different result. They argued that the PBL approach has no effects on decreasing students' level of classroom anxiety. They even claimed that the PBL problems/scenarios could increase students' level of anxiety. This means that learners attending PBL classes might find problems confusing and challenging.

Conclusions

The findings of the present study suggest that the PBL approach efficiently motivates learners to communicate and interact within the classroom context. The high level of willingness to communicate shown by the learners in the online PBL group rationalized the effectiveness of both PBL as a teaching approach and the online form of teaching as a medium of instruction. It should be noted that although the highest level of WTC was observed in the online PBL class, the students in the conventional PBL group also outperformed those in the control group. EFL learners' WTC in the PBL groups showed learners' active participation. It is, therefore, concluded that the PBL approach leads to the active involvement of EFL students, which seems necessary for optimal learning. Therefore, employing the PBL approach both encourages learners' interaction within the context of the class and empowers them to practice the target language outside of the classroom context, by triggering the learners' WTC.

It was also realized that in both online and conventional PBL classes, students showed a significant level of self-efficacy compared to the control group. This means that PBL provided EFL learners with more engagement based on the group activities which were accompanied by more collaborative features when they participated in online PBL groups. Therefore, learners in the online and conventional PBL groups felt more self-determining and responsible for their learning as a result of feeling more comfortable in the learning environment. Accordingly, it can be concluded that the application of the PBL approach improves learners' self-efficacy.

EFL learners in the online and conventional PBL groups showed a lower level of classroom speaking anxiety compared to the ones in the control group. In other words, they were not afraid of talking in class, especially when discussing their solutions in the group or with the class. Hence, it can be concluded that PBL helps EFL learners feel less anxious about

speaking with others by practicing the target language. This seems to be due to the experiential aspect of PBL, when learners explore the solutions to the problem/scenario and discuss them with others, that forms an environment with a minimized classroom speaking anxiety. The lowest level of anxiety felt by the learners in the online PBL group is also indicative of the effectiveness of the PBL when offered online.

The findings of this study can deepen language instructors' insights with regard to the ideal environments for increasing students' communicative skills by reproducing an authentic scenario/problem for students to deal with collaboratively. The knowledge of how PBL affects EFL learners' anxiety, self-efficacy and WTC can help teachers to resist the temptation to abandon using PBL because of its practical challenges. In addition, the findings of this study can encourage EFL students to more open and accepting towards PBL because they will realize that, despite the challenge of having to move away from the security of doing their routines, the method will eventually improve their learning by reducing their anxiety and boosting their self-efficacy and WTC. The findings can even have implications for materials developers; they can design materials that involve problem solving, and by so doing push both teachers and learners out of their routines and encourage them to engage with problem solving activities.

However, the implementation of the PBL approach is not without its limitations. Given the fact that PBL is a relative newcomer in the field, training language instructors qualified in the implementation of PBL is of great necessity. Nonetheless, one of the limiting factors in the process of the present study was that it was conducted during the Covid-19 pandemic. As a result, gathering the participants for the placement tests and running the face-to-face PBL classes had to be done with the utmost protective measures. The participants of the present research were delimited to the EFL learners who voluntarily attended private English language institutes in Zahedan, Iran. The implementation of PBL was delimited particularly to the psychological factors including WTC, self-efficacy, and FLCAS; therefore, the results should not be generalized to other affective factors.

Further studies need to address how the PBL approach conceivably impacts the psychometric factors touching learners' rate of learning. Given the vital role of online platforms in offering online PBL classes, exploring the possible influential factors when using online or web-based platforms seems necessary for checking which platforms both influence learners' psychological expectations and best fit into the framework of PBL in language teaching and learning. Moreover, investigating the effects of the PBL approach on other affective factors such as motivation, self-esteem, etc. accompanied by other language skills i.e., writing, reading, and listening are areas worth delving into.

Authors' Contribution

Saieed Moslemi Nezhad Arani: Project administration, Investigation, Visualization, Data curation, Formal Analysis, Writing-Original draft.

Abbas Ali Zarei: Conceptualization, Methodology, Validation, Supervision, Editing manuscript.

Abdullah Sarani: Data collection, Feedback on research stages, Reviewing original draft.

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Conflicts of Interest

All authors certify that they have no affiliations with or involvement in any organization or entity with any financial interest or non-financial interest in the subject matter or materials discussed in this manuscript. No funds, grants, or other support was received.

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AUTHOR(S) BIOSKETCHES

Saieed Moslemi Nezhad Arani holds a Ph.D. in TEFL from Imam Khomeini International University in Qazvin, Iran. His educational journey began with a Bachelor's degree in English Language Translation Studies from Payam-e-Noor University in Aran & Bidgol, which he followed up with a Master's degree in TEFL from University of Sistan and Baluchestan located in Zahedan, Iran. He has contributed to the field of TEFL through several published papers and has attended numerous conferences. His academic interests predominantly lie in language teaching, discourse analysis, computer-assisted language learning, and problem-based learning.

Moslemi Nezhad Arani, S. Visitor Assistant Professor, Teaching English as a Foreign Language, Farhangian Teacher Training University, Zahedan, Iran

moslemi_saieed@pgs.usb.ac.ir

saieed91@yahoo.com

Abbas Ali Zarei an associate professor in TEFL, is a faculty member at Imam Khomeini International University in Qazvin, Iran. He has had 58 books and more than 140 papers published. He has also attended and presented at 80 national and international conferences across the world.

*a.*zarei*@hum.ikiu.ac.ir*

Abdullah Sarani is an Associate Professor in the Department of English Language and Literature, University of Sistan and Baluchestan. He completed his Ph.D. in Applied Linguistics at the University of Delhi, India, in 2005. His primary research areas are second language acquisition, language teaching, discourse analysis, psycholinguistics and stylistics. His research articles have appeared mainly in international journals.

Sarani, A. Associate Professor, Applied Linguistics, University of Sistan and Baluchestan, Zahedan, Iran

sarani_ling@hamoon.usb.ac.ir

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ORIGINAL RESEARCH PAPER

EFL Teachers' Professional Identity as a Predictor of Using Information and Communication Technologies: Practices, Challenges, and Solutions

***M. Zarrabi*[1,3], *M. Mohammadi*[*,2,3], *Z. Seifoori*[1]**

[1] *English Department, Science and Research Branch, Islamic Azad University, Tehran, Iran*
[2] *English Department, West Tehran Branch, Islamic Azad University, Tehran, Iran*
[3] *Applied Linguistics Research Center, Roudehen Branch, Islamic Azad University, Tehran, Iran*

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* Corresponding author
mojtabamohammadi@gmail.com
(+9821) 22612830

ABSTRACT

Background and Objectives: Technology has been hugely integrated into foreign language classrooms and teachers are expected to take a proper position toward using it. Aside from extrinsic factors such as time, equipment, and training, there are also intrinsic factors residing within the teachers like beliefs, teaching experience, and willingness to use technology that can predict their perceptions toward integrating technology in the class. The latter seems to be the reason why teachers do not pay due attention to effectively integrating technology into their practice which is still insufficiently explored. This study aims to investigate the relationship between teachers' professional identity and their perceptions toward Information and Communication Technologies (ICTs) among Iranian EFL teachers and the practices, challenges, and solutions they consider.

Materials and Methods: In this mixed-methods research, out of all Iranian EFL teachers working in universities, language institutes, and schools, 174 were selected using convenience sampling. In the quantitative phase, the participants completed two questionnaires, i.e., Teachers' Professional Identity and Perceptions toward using ICTs. In the qualitative phase, 39 teachers with high levels of perceptions toward using ICTs who were selected to adopt purposeful sampling answered a structured interview. A standard multiple linear regression and frequency analysis were conducted to analyze the data in the quantitative and qualitative phases, respectively.

Findings: The results of standard multiple linear regression revealed that professional identity is a strong predictor of ICT use. Teaching experience, however, is not a determiner in this respect. Also, the result of the triangulation of the data from the survey and the interview showed no corroboration. The qualitative data analysis also indicated several common technological practices of teachers in their classrooms. The teachers' major challenges were categorized as teacher-related (e.g., lack of ICT literacy and professional training; lack of self-confidence and confronting technical difficulties; difficulty in class time management; and preparing technology-based materials), learner-related (e.g., lack of knowledge and being unfamiliar with ICTs; technology as a source of distraction; lack of interest in using technology and cooperation), and institution-related (e.g., weak internet connection; the unfamiliarity of the managers with the concept and denial of advantages of technology; their unsupportive behavior; traditional educational systems and policies; and lack of budget, facilities and equipment). They further suggested some solutions to address the technology-integration issues. They were three types: Solutions that can be handled by the teachers (e.g., increasing their own technological knowledge; being more disciplined, organized, patient, and self-confident; dedicating enough time and attention to their students' needs and selecting appropriate technologies for learners with differing learning styles, age, and interests; and supporting each other in handling technical difficulties). Other solutions can be managed by the institutions (e.g., providing up-to-date facilities and technological tools; holding training courses, workshops, and seminars to increase technological literacy; encouraging and supporting teachers in applying technologies and being innovative). Some other solutions offered by teachers can be addressed by policymakers (e.g., allocating the budget to the institutes and educational centers to provide appropriate technological equipment and high-speed broadband Wi-Fi).

Conclusions: The results of this study clearly demonstrated that high professional identity with all its components (i.e., subject matter, pedagogical, didactic) can positively influence the application of technology in class. Out of these three, teachers' didactical expertise showed a more significant role. This implies that managers and directors of study, besides equipping the educational centers and facilitating access to technology in class, are expected to provide teachers with pre-service and in-service training courses to empower them to be experts in teaching skills and strategies. Raising teachers' awareness about other aspects of professional teachers such as professional ethics/values and their knowledge base is also recommended. These challenges did not very much contradict those that resulted in similar studies in other parts of the world. Despite these problems, teachers continue practicing technology in their classes using a variety of ways like using software and applications, gadgets and tech tools, and the

internet as the major source of any technology-integrated activity. The results of this study could be more generalizable if more volunteers from all around the country took part in it.

NUMBER OF REFERENCES	NUMBER OF FIGURES	NUMBER OF TABLES
76	0	5

مقاله پژوهشی

هویت حرفه‌ای معلمان زبان انگلیسی به عنوان پیش‌بینی‌کننده استفاده از فناوری اطلاعات و ارتباطات: کاربردها، چالش‌ها و راه‌حل‌ها

مریم ضرابی[۱،۳]، مجتبی محمدی*[۲،۳]، زهره سیفوری[۱]

[۱] گروه زبان انگلیسی، دانشکده ادبیات و علوم انسانی، واحد علوم و تحقیقات، دانشگاه آزاد اسلامی، تهران، ایران
[۲] گروه زبان انگلیسی، دانشکده علوم انسانی، واحد تهران غرب، دانشگاه آزاد اسلامی، تهران، ایران
[۳] گروه زبان انگلیسی، مرکز تحقیقات زبان شناسی کاربردی، واحد رودهن، دانشگاه آزاد اسلامی، تهران، ایران

چکیده

پیشینه و اهداف: فناوری تا حد زیادی در کلاس‌های درس زبان‌های خارجی وارد شده است و انتظار می‌رود معلمان بتوانند در استفاده از آن موضع مناسبی اتخاذ کنند. علاوه بر عوامل بیرونی مانند زمان، تجهیزات و آموزش، عوامل درونی مانند باورها، تجربه تدریس و تمایل به استفاده از فناوری معلمان می تواند استفاده آن ها از فناوری در کلاس را پیش بینی کند. به نظر می رسد عوامل درونی می توانند دلیلی بر عدم توجه کافی معلمان به ادغام مؤثر فناوری در تدریس باشند. این مسئله هنوز به اندازه کافی مورد بررسی قرار نگرفته است. این پژوهش با هدف بررسی رابطه بین هویت حرفه‌ای معلمان و درک آن‌ها از کاربرد فناوری‌های اطلاعاتی و ارتباطاتی در بین معلمان ایرانی زبان انگلیسی و شیوه‌ها، چالش‌ها و راه‌حل‌هایی که مدنظر آن‌ها است، انجام شده است.

روش‌ها: در این پژوهش مختلط، از بین تمامی معلمان زبان انگلیسی شاغل در دانشگاه‌ها، موسسات زبان و مدارس، ۱۷۴ نفر به روش نمونه‌گیری در دسترس انتخاب شدند. در مرحله کمّی، شرکت کنندگان دو پرسشنامه هویت حرفه ای معلمان و پرسشنامه درک استفاده از فناوری اطلاعات و ارتباطات را تکمیل کردند. در مرحله کیفی، ۳۹ معلم که سطح بالایی در استفاده از فناوری اطلاعات و ارتباطات در کلاس داشتند با روش نمونه گیری هدفمند انتخاب شدند وبه سئوالات مصاحبه ساختاریافته پاسخ دادند. برای تجزیه و تحلیل داده ها روش رگرسیون خطی چندگانه استاندارد و تحلیل فراوانی به ترتیب در فاز کمّی و کیفی انجام شد.

یافته‌ها: نتایج رگرسیون خطی چندگانه استاندارد نشان داد که هویت حرفه‌ای پیش‌بینی‌کننده قوی برای استفاده از فناوری اطلاعات و ارتباطات است. با این حال، مشخص شد که تجربه تدریس در این زمینه نقشی ندارد. نتیجه بررسی داده‌های حاصل از پرسشنامه و مصاحبه مشابهتی نشان نداد. به علاوه، داده‌های کیفی، چندین شیوه متداول استفاده از فن‌آوری از سوی معلمان را در کلاس‌های درسشان نشان می‌دهد که در دو دسته ابزارها و برنامه‌های آموزشی (مانند ابزارهای چند رسانه‌ای، ویدئو پروژکتور، ...) و فعالیت های آموزشی مبتنی بر فناوری (ضبط صدا/فیلم، بازی‌های رایانه‌ای، ...) طبقه‌بندی می‌شوند. چالش‌های عمده معلمان نیز به سه گروه تقسیم می‌شود: چالش های مرتبط با معلم (نظیر فقدان سواد فناوری اطلاعات و ارتباطات و آموزش حرفه‌ای، عدم اعتماد به نفس، ...)، چالش های مرتبط با یادگیرنده (مانند عدم آگاهی و ناآشنایی با فناوری اطلاعات و ارتباطات،...) و چالش های مرتبط با نهادهای رسمی (ضعف اتصال به اینترنت، ناآشنایی مدیران با مفهوم و نفی مزایای فناوری و رفتار غیرحمایتی آنها،...). همچنین راه حل‌هایی برای رفع این چالش‌ها پیشنهاد شد که در سه دسته طبقه بندی شدند: راه‌حل‌هایی که مسئولیت انجامش برعهده معلمان است (افزایش دانش فنی معلمان، ارتقاء نظم، سازمان‌دهی،

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واژگان کلیدی:
هویت حرفه ای
فناوری اطلاعات و ارتباطات
چالش‌های فناوری اطلاعات و ارتباطات
ادراک معلمان
عملکرد آموزشی

* نویسنده مسئول
mojtabamohammadi@gmail.com
۰۲۱-۲۲۶۱۲۸۳۰

شکیبایی واعتماد به نفس، توجه کافی به نیازها و سبک‌های یادگیری دانش‌آموزان،...). راه‌حل‌های دیگر (ارائه امکانات و ابزارهای فن‌آوری به‌روز، برگزاری دوره‌های آموزشی،...) بر عهده مؤسسات آموزشی است. برخی دیگر از راه حل‌های ارائه شده از سوی معلمان باید مورد توجه قانون گذاران قرار گیرد (تخصیص بودجه برای مؤسسات و مراکز آموزشی برای خرید تجهیزات فَناوری مناسب، ...).

نتیجه‌گیری: نتایج این مطالعه به وضوح نشان داد که هویت حرفه ای بالا و تمام مولفه های آن (تخصص در موضوع، تخصص در ارزش آفرینی آموزشی، تخصص در تدریس) می تواند بر کاربرد فناوری در کلاس تأثیر مثبتی بگذارد. از بین این سه، تخصص در تدریس نقش مهمتری را نشان داد. این امر حاکی از آن است که از مدیران آموزشی انتظار می رود علاوه بر تجهیز مراکز آموزشی و تسهیل دسترسی به فناوری در کلاس، امکان برگزاری دوره های آموزشی پیش از خدمت و ضمن خدمت معلمان را نیز فراهم کنند تا آنان را در مهارت ها و راهبردهای آموزشی توانمند سازند. افزایش آگاهی معلمان در مورد سایر جنبه های حرفه‌ای معلمان نظیر اخلاق یا ارزش‌های حرفه‌ای و تقویت بنیه علمی آنها نیز توصیه می شود. این چالش‌ها چندان با چالش‌هایی که منجر به مطالعات مشابه در سایر نقاط جهان شد، تناقض نداشت. علی‌رغم این مشکلات، معلمان با استفاده از روش‌های مختلف مانند استفاده از نرم‌افزارها و برنامه‌های کاربردی، ابزارهای فناوری و اینترنت به عنوان منبع اصلی هر فعالیت فناورانه، به تمرین فناوری در کلاس‌های خود ادامه می‌دهند. از محدودیت های این مطالعه می توان به این نکته اشاره کرد که اگر داوطلبان بیشتری از سراسر کشور در آن شرکت می کردند، نتایج این مطالعه می‌توانست قدرت تعمیم‌پذیری بیشتری داشته باشد.

Introduction

We have always been involved in (re)shaping a *self* on the way to make our dreams come true. This attempt has its own influence on different aspects of our life. Therefore, our identity guides us to set goals, define objectives, and demonstrate the route to take [1]. As Beijaard et al. asserted, “identity is not something one has, but something that develops during one’s whole life” [2, p. 107]; therefore, the process of developing one’s identity takes time and experience of encountering various situations [3].

Teachers’ professional identity, as one aspect of identity, deals with the pedagogical, social, cultural, and political contexts of the teachers. Scholars believe that most of the teachers' practices in the classes, from the decisions they make to the methods and techniques they adopt, and their rapport with the learners are part of the teachers' professional identity [2] [4]. According to Lai and Jin [5], one of the areas in which professional identity (PI) may play an important role is related to teachers’ perception of and integration of technology for pedagogical purposes. Different aspects of teachers’ professional identity may affect differently on teachers’ approaches toward the integration of technology.

The adoption of Information and Communication Technologies (ICTs) has recently attracted the attention and interests of many teachers and educators since their role in the process of teaching and learning has been confirmed as beneficial [5-13]. EFL teachers are no exception. There are a number of benefits to the use of ICTs in language classrooms: fostering the visualization of abstract ideas [14], enhancing motivation, and self-confidence for the students [15], developing students’ academic achievement [16], and establishing collaborative activities using ICTs [17]. However, the review of several research related to the integration of ICTs in the classroom context showed that there are not unanimous results in terms of the attitude and perception of the teachers’ tendency to use technology in the classroom. The research indicated that generally teachers had either high perceptions toward the adoption of ICTs [18-21] or moderate level perceptions of it [22]. In terms of practical integration of technology into the

classroom, nevertheless, the literature shows that teachers do not usually integrate it into their teaching effectively [18][21-24]. Furthermore, other scholars [25][5] have underlined that a beneficial online learning environment that promotes professional identity requires "knowledge of both the affordances of pedagogies and technologies and of the nature of professional identity" [25, p. 424].

Research also revealed that there are two factors affecting the use of technology in language classrooms: extrinsic and intrinsic factors. The former refers to school climate and culture and all the available resources like training courses, educational planning, and technological equipment [5] [26-28]. The latter, however, includes the beliefs and value systems of the teachers about teaching, learning, digital literacy, and self-efficacy beliefs about technology use [5] [29-31]. One of the barriers to the development of teachers in extrinsic factors (e.g., the supply and adoption of technology), as mentioned by [5], is related to intrinsic factors (e.g., their belief or professional identity). In other words, teachers' perception of ICTs is believed to be related to their beliefs and perceptions about language learning and identity in the context of their profession.

The facilitating and motivating role of technology integration in the educational process has triggered most teachers around the world to try to adopt them in their classes. However, there are still teachers who are not willing to integrate it into their teaching due to some barriers that prevent them from benefiting from the affordances of technology in their classes. According to Lai and Jin [5], one major reason behind teachers' (un)integration of technology may lie in the teachers' professional beliefs and identity. It seems worthwhile to investigate how these two variables are correlated and examine the barriers in order to encourage teachers to adopt and integrate technology into their pedagogical practices.

This study is conducted with the purpose of examining whether the components of professional identity can predict Iranian EFL teachers' perception of ICT. It further aims to investigate whether teaching experience has any effects on teachers' use of ICT. Moreover, the common technology-integrated practices, challenges, and solutions of Iranian EFL teachers are explored thoroughly.

To fulfill the above purposes, the following research questions were guided in this study:

- Do different components of Iranian EFL teachers' professional identity predict their perception toward ICTs?
- Does teaching experience have any significant effect on teachers' perceptions toward ICT?
- How do the teachers' use of ICT corroborate with how they perceive themselves as ICT users?
- What are the common technology-integrated practices among Iranian EFL teachers?
- What are the common technology-integrated challenges and solutions proposed by Iranian EFL teachers?

Review of the Related Literature

Teachers' Professional Identity

Literature has witnessed a few theoretical frameworks to measure the professional identity of teachers. Hanna et al. [32, p. 8] investigating the quantitative measurement instruments reported that scholars have adopted such theories as "Erikson's Theory of identity development [33]; Bourdieu's theory of social capital [34]; and the expectancy-value theory [35]". The instruments by Beijaard et al. [2] and Lamote and Engels [36] are claimed to be inspired by the theoretical works of Bromme

[37] and Puurula and Löfström [38], respectively.

These theoretical issues viewed and defined professional identity differently. According to Beijaard et al., teachers' PI is a combination of "the teacher as a subject matter expert, the teacher as a pedagogical expert, and the teacher as a didactical expert" [2, p. 750]. Pennington considered teacher identity as "a construct, mental image or model of what 'being a teacher' means that guides teachers' practices as they aim to enact 'being a teacher' through specific acts of teacher identity" [39, p. 17]. More recently, identity is considered as a dynamic concept that is affected under different circumstances. Identity is a dynamic phenomenon that is constantly evolving rather than being stable [40]. Richardson and Watt also regard identity as "an elusive dynamic and multidimensional construct that changes shape depending on the theoretical lens through which it is observed" [41, p. 38]. When professional identity is studied within the pedagogical contexts, teachers are the first agents to consider. Considering teaching as a socially constructed activity [42], it is of no surprise that teacher identity is, according to Bakhtin [43], an ongoing process of relationship between teacher and others. That is why Lasky defined teacher professional identity as "how teachers define themselves to themselves and to others" [44, p. 901]. Alsup [45] even finds an interplay between the characteristics of good teachers and their identity development. Meihami and Werbinska [46] also investigated the role of action research to enhance teachers' professional identity. With the changes in the ecosystem of teaching and the considerable integration of technology, the need for teachers to adapt themselves and their teaching practices to these changes emerges. This can lead to changes to the identity they have already established. Teachers, as Valentyn [47] asserts, tune into technological development in their teaching practices and take different roles as mentors, coaches, supporters, guides, and motivators which can help develop the teachers' identity.

Information and Communication Technologies (ICTs)

ICT is usually used with the words, 'computer' and 'technology'; but the terms 'digital technology' or 'Web 2.0' coined by Ertmer et al. [48] and Sadaf, et al. [49] can be the best representative of it. Toomey as cited in Lloyd [50] defined ICTs from the teaching and learning aspect as different technologies including hardware, software applications, and connectivity that are used to access, gather, manipulate, present, and communicate information. The significance of ICT is that it integrates multimedia, communication, and computer-based technologies considering their dynamicity and increasing usage.

Studies on ICTs are of several types. Some are in relation to the integration of ICT with education and its effectiveness [51-54] and some others have been conducted to identify teachers' perceptions of and beliefs about using ICTs [55] [6-8], [10-11][13], the majority of them revealed both positive impacts and perceptions toward ICTs integration. Also, there are other correlational studies that have focused on the relationship between teachers' beliefs about ICT integration and other variables like their pedagogical beliefs [48] [56-58] indicating a mutual relationship between teachers' pedagogical beliefs and their use of technology.

Regarding the effect of teachers' years of experience, their gender, age, and prior technology training, different studies have been performed indicating contradictory findings. For example, Lam [7] found that all the above-mentioned variables do not affect teachers' use of technology. Also, Yang and Huang [13]

reported a positive relationship between technology-integrated teaching activities, teachers' prior technology training, and the school context, while less experienced teachers showed more interest in using technology in their classes. In addition, Korthagen [59] found that experience had a reverse effect on teachers' willingness to use ICT tools. In another study, Rahimi and Yadollahi [54] indicated a negative correlation between using ICTs and teachers' experience, age, and computer anxiety, and a positive one with academic degrees, and computer literacy and ownership, while gender and attitude showed no effect on integrating ICTs. Chung [55] found a strong correlation between teachers' beliefs in implementing technology and their technological training, proficiency, and context; however, regarding teaching experience and age, results were varied. Moreover, Karakaya's study [51] revealed no significant impact of age and gender while academic degrees and teaching experience had a strong effect. In contrast, Scrimshaw [60] found that gender affects teachers' ICT integration as male teachers use technology more than females.

In addition, some major challenges in using ICTs by teachers were reported to be the lack of access to ICT tools and technological training [61-62], lack of teachers' confidence and technological skills [63], large classrooms, lack of technical support and ICT skills of both teachers and learners, and teachers' conservative attitudes toward using ICTs [64], and most importantly, lack of teachers' enough time to cover the syllabus was considered as an important issue [65]. Furthermore, the intended ICT tool that was mostly used by teachers was PowerPoint while utilizing other tools varied from teacher to teacher. Al-Senaidi et al. [65], in support of Ertmer [66], and Snoeyink and Ertmer [67], identified two types of barriers: external, such as lack of technology access, resources, and support, and internal barriers like teachers' conservativeness, lack of confidence and knowledge about using technology. They believed that most teachers are not ready to accept and implement technological tools and do not have enough awareness of the benefits of ICTs. Additionally, based on ICT barriers' categorization by Veen [68], researchers categorized these barriers into two levels of individual (e.g., lack of time, access, and technology use training) and institutional (e.g., traditional type of teaching, lack of time, and understanding the benefits of technology). In another study by Groff and Mouza [69], ICT barriers were categorized into the Context (e.g., school), Innovator (e.g., teacher), Innovation (e.g., project), and Operator (e.g., student) suggesting that training teachers to implement ICT and both peer and institution support can be effective in resolving these barriers.

Literature reveals that most of the studies have just focused on one aspect of ICTs like the effectiveness of utilizing ICTs, ICT integration barriers, benefits of using ICTs, and teachers' perceptions and beliefs about the use of ICTs. Few studies have explored the relationship between perceptions toward ICTs and other variables [57-58]. More specifically, there is little literature to deal with teachers' identity, as instances of intrinsic factors, in the development of the perception of the teachers toward the adoption of ICTs as an extrinsic factor in language classes effectively. Moreover, there is a paucity of research [54] regarding how teachers utilize ICTs effectively in their classes, the problems they often face while trying to integrate technology into their practices, and providing solutions or strategies to handle the existing challenges in the context of Iran. In addition, there are contradictory findings in different studies exploring the effect of variables such as teachers' years of

experience on their perceptions toward using ICTs and therefore further research is needed in this area as well.

To fill the above-mentioned gaps, this study aims to examine whether the components of EFL teachers' professional identity are correlated with their perception toward ICTs and to investigate if teachers' experience has any effects on their perceptions toward the use of ICT. It further explores the common technology-integrated practices, challenges, and solutions, and whether and how Iranian EFL teachers integrate these practices into their pedagogical context.

Method

Participants

174 Iranian EFL teachers at universities, institutes, and schools were the participants of this study. According to Freeman's [70] definition of the level of experience, they were divided into novice (less than three years) and experienced (five or more years). They were from different age groups from 20 to above 40 years including 108 female (62%) and 66 male (38%) participants. For the quantitative phase of the study (administering the questionnaires), teachers were selected based on a convenience sampling method out of those who volunteered to take part in the study. This sampling method was adopted since we aspired to collect data from larger sample of teachers. Moreover, selecting the samples voluntarily can enhance quality and the originality of the data and the result. For the qualitative phase, the participants answered an online structured written interview regarding their practices and challenges of technology integration and suggested some solutions.

Instruments

Teachers' Professional Identity Inventory

The instrument, developed by Beijaard et al. [2], was used to measure the teachers' perception of their professional identity. The questionnaire encompasses the features of teachers as being experts in three fields: subject matter - "a teacher's professional knowledge base" [2, p. 751], pedagogical – "the ethical and moral features of the teaching profession" [2, p. 751], and didactic - the planning, execution, and evaluation of lessons" [2, p. 752]. The responses to this 14-item questionnaire are on a Likert scale ranging from *strongly agree* to *strongly disagree*. Cronbach's alpha showed the reliability index of the instrument as 0.8.

Perceptions towards ICTs Scale

Developed by Baş et al. [71], the Perceptions toward ICTs Scale measures EFL teachers' perception toward the adoption of information and communication technologies in their teaching-learning process. The survey has 25 items, and the teachers respond by choosing one of the choices from strongly agree to strongly disagree. The construct includes three components of attitudes, usage, and belief. The reliability index was calculated as 0.9 using Cronbach's alpha.

The online interview

This was a four-item structured interview being held online in written mode. This type of interview was adopted as we were constrained in terms of the accessibility of the participants and for the straightforward and efficient analysis of the data, although it limited the number of questions and reduced the depth of the answers. The first interview question was asked to triangulate the responses collected using the questionnaires. While the second question asked the technological practices that teachers with high ICT perception used in their

classes, the third and the fourth questions respectively inquired about the challenges and the related solutions in adopting technology.

Procedure

To collect the data, an online call was shared for participants in different EFL teachers' groups for those who were interested to participate in the study. For those EFL teachers who did not have access to social media, the two questionnaires were administered in person.

In the quantitative phase, the questionnaires were used to investigate the relationship between teachers' professional identity and their perception of using technology in their classes. The data gathered in this phase were analyzed statistically using SPSS. To triangulate the data, in the qualitative part of the study, all participants were asked to answer the first question of the interview. However, those participants who scored high on the ICT scale were invited to answer the second, third, and fourth interview questions to explore their practices, challenges, and solutions to adopting technology.

Design

This study is an explanatory sequential mixed-methods research. Based on Creswell and Clark [72], in this type of research the purpose is to use "a qualitative strand to explain initial quantitative results" [72, p.133]. In the quantitative phase, two questionnaires were administered to find out if teachers' professional identity is correlated with their perceptions toward ICTs. In the qualitative phase, an online structured interview was used to measure the teaching practices using technology, and the challenges and solutions of integrating ICT in the process of language teaching.

Results and Findings

To answer the first research question, a standard multiple linear regression was conducted, and the teachers' professional identity components, that is, subject matter field, didactical field, and pedagogical field were entered into a regression model to investigate whether they could predict teachers' ICT use (Mean = 99.47, SD = 13.015). Table 2 shows the descriptive statistics of the predictors (i.e., subject matter field, didactical field, and pedagogical field) and the criterion variable (i.e., use of ICT) in the regression model.

The required statistical assumptions for conducting multiple regression were evaluated and the results showed no violations of normality, linearity, and homogeneity of variance of residuals. The Durbin-Watson test of autocorrelation of residuals indicated their independence (it is between 1.5 and 2.5, see Table 4). Likewise, there was no collinearity in the data with the condition index lower than 15 (see Table 1), as recommended by Tabachnick and Fidell [73]. Also, all the VIF estimates were less than the recommended value of 10 and there was no sign of multicollinearity. Moreover, all the skewness and kurtosis measures were between -2 and +2, so the normality assumption was met.

Table 4 and Table 5 show that R is significantly different from zero, $F(3,169) = 992$, $p = .00$, and R2 at 0.946, demonstrating the significance of this regression model. The adjusted R2 value of 0.945 indicates that 94% of the variability in teacher professional identity is predicted by subject matter, didactical and pedagogical field. This reveals that teacher professional identity, as a whole, predicts 94% of the variance in teachers' perception of ICT.

As can be seen in Table 5, the subject matter field (B = 2.1, S.E = 0.13, β = .35, t = 16.27, $p = .00$), didactical field (B = 1.7,

S.E = 0.11, β = 0.4, t = 15.79, *p* = .00) and pedagogical field (B = 2, S.E = 0.12, β = 0.387, t = 15.9, *p* = .00) all are found to be the significant predictors of teacher perception of ICTs. In addition, the Standardized Coefficient reveals that, among the components of professional identity, the didactical field has the strongest relationship with the teachers' use of ICT.

To answer the second research question, that is, whether teaching experience had any significant effect on teachers' perception of ICT, the scores of both novice and experienced teachers on the Perceptions toward ICTs Scale were examined based on their frequency. The teachers whose total scores on the ICT scale were at the percentile value of 70 and above and teachers with the percentile value of 19 and below were considered as high and low ICT users respectively. It was revealed that from 124 experienced teachers only 30 (24%) had high and 18 (15%) had low perception toward using ICT. Moreover, from 50 novice teachers, 9 (18%) gained high scores and 16 others (32%) scored low on this questionnaire. Totally, most of the participants gained medium scores (60%) from the ICT questionnaire, irrespective of whether they are experienced or novice. As a result, teaching experience cannot be the only determiner of teachers' technology integration.

Table 1: Collinearity diagnostics

Model	Dimension	Eigenvalue	Condition Index	Variance Proportions			
				(Constant)	Subject Matter field	Didactical field	Pedagogical field
1	1	3.974	1.000	.00	.00	.00	.00
	2	.012	18.396	.29	.10	.00	.62
	3	.009	20.873	.46	.83	.01	.01
	4	.005	29.010	.24	.07	.99	.37

Table 2: The descriptive statistics of predictor and criterion variables in regression equation

	N	Min	Max	Mean	Std. Deviation	Skewness		Kurtosis	
						Statistic	Std. Error	Statistic	Std. Error
ICT's	174	60	125	99.47	13.015	-.044	.184	-.307	.366
Subject-Matter	174	9	20	15.49	2.120	-.123	.184	-.232	.366
Didactical	174	18	30	24.99	2.916	.092	.184	-.659	.366
Pedagogical	174	9	20	15.95	2.429	-.123	.184	-.227	.366
Valid N (listwise)	174								

Table 3: Test of significance of regression equation

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	26249.465	3	8749.822	992.897	.000
	Residual	1489.298	169	8.812		
	Total	27738.763	172			

Table 4: Test of independence of residuals of simple regression analysis

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics					Durbin-Watson
					R Square Change	F Change	df1	df2	Sig. F Change	
1	.973	.946	.945	2.969	.946	992.897	3	169	.000	1.969

Table 5: Regression coefficients of regression analysis

Model		Unstandardized Coefficients		Standardized Coefficients			Collinearity Statistics	
		B	Std. Error	Beta	t	Sig.	Tolerance	VIF
1	(Constant)	-9.953	2.081		-4.783	.000		
	Subject Matter field	2.132	.131	.356	16.276	.000	.666	1.502
	Didactical field	1.772	.112	.406	15.799	.000	.481	2.077
	Pedagogical field	2.021	.127	.387	15.903	.000	.535	1.869

In the qualitative phase, to answer the third research question, the results of teachers' ICT scale were triangulated with the results of the first interview question inquiring whether they perceive themselves as high or low technology users in the class. Results revealed that 42% (n=39) of the teachers were high ICT users and 47% (n=34) were low technology users. Furthermore, the teachers' responses to the first interview item were also analyzed. Out of 174 who participate in the study, 10% (n=17) remain the first item of the interview unanswered, 54% (n=85) considered themselves as high users of technology, and 21% (n=33) perceived themselves as low. As can be seen above, while the percentage of high and low users of ICT were rather equal on the scale, the number of teachers who perceive themselves as high users of ICT in the interview, was significantly more than those who perceive themselves as low users. This shows that the results are not well corroborated.

The fourth research question inquiries about the common practices of EFL teachers. Content analysis was used to extract the most frequent content and report it. First, all the answers were saved in the form of a written corpus. The researcher, then, scanned all the answers and counted the instances of the teaching practices presented by those interviewees who acknowledged the use of technology in their classes. The answers were tabulated along with the frequency and the related percentage to be analyzed. The results indicated that the most common representation of integrating technology that Iranian EFL teachers adopt in their classes were classified under two categories of educational gadgets and applications, and technology-based educational activities. The educational gadgets that the teachers most commonly used were multimedia, cellphones, Over-Head Projector (OHP), laptops and computer devices, and interactive whiteboards; while the applications they mainly applied in their classes were PowerPoint, social media (e.g., Instagram, YouTube, Telegram, Email, …), pdf, and less commonly used applications were automated feedback tools, Adobe Connect, Grammarly, online dictionaries, Kahoot, Padlet, Dojo, Word wall, AI Apps (e.g., interactive bots), and Chat GPT. The technology-based educational activities teachers referred to were recording audio/videos, gaming, using songs and pictures, searching online, digital storytelling, vodcasting, podcasting, doing exercises and quizzes, and translating.

The fifth research question was investigated analyzing the corpus of answers to the online interview. The content analysis was adopted to analyze the data as well. The question asked about the challenges and suggested solutions for integrating technology into their classes. The challenges were categorized into three types: learner-related, teacher-related, and institution-related challenges. The major teacher-related challenges were related to teachers' lack of ICT

literacy, training, and lack of self-confidence when confronting technical difficulties in their classes. Moreover, most teachers have problems in managing their time to "make a balance between using technology in class and covering students' textbooks" thoroughly. Also, preparing technology-based materials necessitates a great amount of time and energy and can be a burden for teachers. Some asserted that it "may disrupt the flow of a lesson and also may cause frustration for both teachers and students". Additionally, some teachers acknowledged that "managing and controlling the classes including heterogeneous students [with respect to their degree of interest and familiarity with technology] is not an easy task to do". The learner-related challenges as reported by teachers contained their lack of knowledge and being unfamiliar with ICTs, specifically adult learners. Some others mentioned that technology "maybe a source of distraction for students who misuse it for non-educational purposes". In addition, some students are uninterested in using technology and not cooperative enough since they do not believe in the benefits of using technology. The institution-related challenges mainly included weak internet connection, the unfamiliarity of the managers with the concept and denial of ICTs advantages, their unsupportive behavior, traditional educational systems and policies, and lack of budget, facilities, and equipment.

The solutions suggested by the teachers were classified into three types as well: ones which can be handled by the teachers, those which can be managed by the institutions, and others which can be addressed by policymakers. The teachers' role in classroom technology integration was multifaceted as mentioned by themselves. Teachers not only have to increase their own technological knowledge and literacy, but they should also consider many factors in this regard. According to the solutions they suggested in the interview, teachers should be more disciplined, organized, patient and self-confident. They should dedicate enough time and attention to their students' needs to be able to motivate and engage them by using the type of technologies appropriate to their student's learning styles, age, and interests. Teachers can even ask tech-savvy students to help and collaborate in tackling technical problems during the class. They can save and manage class time by familiarizing students with the technology they are going to use before class time. They are responsible for increasing students' interest and awareness by talking with the students about the advantages of using technology. Teachers can also support each other in handling technical difficulties. Other solutions were related to the institutions to provide up-to-date facilities and technological tools including free broadband Internet connection; hold training courses, workshops, and seminars to increase technological literacy among both teachers and learners; encourage and support teachers in applying ICTs and being innovative. Also, requesting the expansion of class time was another solution suggested by some teachers. Furthermore, a few teachers referred to the responsibility of policymakers to alter their attitudes towards internet access policies in Iran and asked for the allocation of budget for the institutes and educational centers to provide appropriate technological equipment and free broadband Wi-Fi.

Discussion

Integration of technology in EFL classes is a new trend but the way it is related to the teachers' individual differences like their identity needed further attention. This study revealed that the teachers' professional identity and their

perception of ICTs are strongly correlated. The results corroborated the findings of the studies on how extrinsic factors like school climate and culture and resources [5] [26-28] and intrinsic factors like beliefs and value systems of the teachers [29-31] are related. It is revealed that the components of professional identity - the subject matter, pedagogic, and didactical - are strong predictors of teachers' perception of ICTs. This is in line with studies done by Ding et al. [74], Ertmer et al. [48], Sang et al. [57], and Tondeur et al. [58] which indicated a strong correlation between beliefs about the use of technology and the teachers' pedagogical beliefs. The results of this research further indicated that among the various components of professional identity, the didactical field could have a significant contribution in predicting teachers' perceptions toward using ICTs. Therefore, it can be argued that practitioners who improve their professional identity would be admittedly more motivated and confident in using ICTs in their classes.

A descriptive investigation of the effect of teaching experience on teachers' perception of ICTs demonstrated that the level of teaching experience has no significant effect on their use of ICT in the classes. That is, using technology is not related to the years of teaching experience. This finding is in line with the findings of Lam [7] and Mahdi and Al-Dera [75], stating that teachers' years of experience have no effect on teachers' use of technology and is in contrast with Karakaya's study [51] in which there was a strong effect of teaching experience on using ICTs. Contradictory findings reveal the need for further exploration of this issue in different contexts with other participants.

The third research question was a methodological triangulation of the data collected from the scale and the first item of the interview. It was indicated that few teachers acknowledged themselves as low users of technology answering the interview question while their scores on the ICT scale revealed a higher percentage of teachers as low ICT users. Also, little match was found regarding the number of users with high perception. Teachers explicitly perceive themselves as more ICT users than what is implicitly resulting from the answers to the items of the scale. These findings can be justified as teachers psychologically saw their performance more idealistically than what they practiced.

Regarding the fourth research question which inquired about the common practices of EFL teachers, social media and power points were among the most frequent educational gadgets while applications and recording audio/videos and gaming were reported as mostly used in technology-based educational activities. This is very similar to Ding and Glazewski's study [74] in which PowerPoint slides and videos were reported to be used mainly for various content-specific purposes. It is also in accordance with Rahimi and Yadollahi's findings [54], which indicated the willingness of teachers to use mostly simple devices and applications not to take a great amount of their class time.

Examining the teachers' responses regarding the challenges and solutions revealed that each of the three types of challenges and solutions (teacher-related, learner-related, and institution-related) included some internal factors in addition to the external ones which is like the classification of Al-Senaidi, et al. [65], Ertmer [66], and Snoeyink and Ertmer [67]. These internal factors are related to teachers, learners, institutions, and even policymakers' beliefs about technology and its effects on improving learning. Specifically, teachers' lack of confidence or their conservative attitude towards using technology can be related to their beliefs and professional identity. In the same way, learners' acceptance, or avoidance

of applying ICTs can be rooted in their beliefs about its benefits or their lack of self-confidence. Furthermore, those institution managers and policymakers who reject technology in favor of traditional teaching methods do not believe in the advantages of using ICTs. Thus, it can originate from individuals' views, beliefs, and identities. Furthermore, the classifications of technology-integrated challenges as context, innovator, innovation, and operator [69] and individual and institutional [68] have more or less referred to the same challenges as that of this study. The solutions proposed by teachers in this study are partly like the implications provided by Al-Senaidi et al. [65], suggesting that institutions to provide technical support and training, and allocate more time for teachers to develop their technological skills. This study also indicates the same challenges that Rahimi and Yadollahi [54], and Maru et al. [63] referred to in their studies. Rahimi and Yadollahi [54] stated that teachers found ICT use as an extra burden, and they mostly used simple applications to save time, and Maru et al. [63] referred to lack of ICT literacy and support as external factors and motivation and confidence besides inadequate access to the internet as the main challenges. The solutions that teachers proposed in this study were in accordance with Rahimi and Yadollahi [54], in which emphasis was on raising teachers' awareness of the values of technology integration, empowering teachers' technical and professional skills, and colleagues' support. Additionally, Karakaya [51], indicated the need for holding technology training courses for teachers.

Overall, the results of the qualitative analysis were similar to those of studies in the literature in terms of the challenges teachers perceive to encounter in their profession in the adoption of technology in class. Like the results of this study, the literature is rich with the challenges like access to ICT tools and technological training [61-62], lack of teachers' confidence and technological skills [10], lack of technical support and ICT skills of both teachers and learners and teachers' conservative attitudes toward using ICTs [64].

Conclusions

Using technology in class is not all a matter of having the amenities and equipment, other factors are in play that can enhance its practice by the teachers. Intrinsic factors such as the belief and identity of the teachers can also act as determiners. The results of this study clearly demonstrated that professional identity with all its components can influence the application of technology in class. Above all three, teachers' didactical expertise can have a major role. This implies that managers and directors of study, besides equipping the educational centers and facilitating access to technology in class, are expected to provide teachers with pre-service and in-service teacher training courses to empower them to be experts in teaching skills and strategies. Raising the teachers' awareness about the other aspects of professional teachers such as professional ethics/values and their knowledge base is also recommended. Further follow-up classroom observations, as Warschauer [76] proposed, to ensure they properly apply what they have learned in training programs is deemed necessary.

In terms of the challenges teachers face, it seems that the Iranian EFL context is not so much different. Teachers as thriving agents of any educational setting suggest solutions which are on the part of the school officials, policymakers, and the teachers themselves. Challenges like learners' and teachers' lack of ICT literacy, training, lack of self-confidence and distraction when confronting technical difficulties in their classes, balanced classroom

time management, availability of broadband connection, managers' unsupportive reactions to the use of ICT and the traditional and educational mindset and system are all involved in making barriers to integrate technology into classroom practices. Despite these problems, teachers are recommended to continue practicing technology in their classes using a variety of ways like using software and applications, gadgets and tech tools, and the internet as the major source of any technology-integrated activity. Moreover, school officials and policymakers are recommended not only to provide technological facilities and broadband connections, but also to hold training courses and workshops and encourage innovations to apply ICT in their classes. The results of this study could be more generalizable if more volunteers from all around the country took part. Out of three major solutions for technology integration in language classes, government-related, institution-related, and teacher-related factors, the one with utmost importance is the teacher-related one which implied that any change in the teachers' perception starts from inside, and improving teacher's professional identity is a case in point.

Author Contribution

M. Zarrabi: Conception and design, acquisition of data, analysis and interpretation of data, drafting of the manuscript, statistical analysis, and administrative, technical, or material support

M. Mohammadi: Acquisition of data, drafting of the manuscript, critical revision of the manuscript for important intellectual content, and supervision

Z. Seifoori: Critical revision of the manuscript for important intellectual content, administrative, technical, or material support, and supervision

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Conflict of Interest

The author has no conflicts of interest.

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AUTHOR(S) BIOSKETCHES

Maryam Zarrabi is a PhD candidate of TEFL at Islamic Azad University, Science & Research Branch, Tehran. She is a university instructor now and has been teaching for 15 years. She has presented and published in several national and international conferences and journals. Her areas of research interest include teacher education, computer assisted language learning (CALL), language assessment, and psychology of language learning.

Zarrabi, M. Lecturer, Applied Linguistics, English Department, Science and Research Branch, Islamic Azad University, Tehran, Iran.

maryam.zarrabi@srbiau.ac.ir

Mojtaba Mohammadi is assistant professor of applied linguistics at Islamic Azad University, West Tehran Branch. He has been teaching English for 27 years and has run teacher training courses for 17 years. He has papers, book chapters, and encyclopedia entries published by Routledge, Palgrave Macmillan, and Wiley & Sons publications. His areas of interest are language assessment, technology-enhanced language learning/teaching/testing, and teacher education.

Mohammadi, M. Assistant professor, Applied Linguistics, English Department, West Tehran Branch, Islamic Azad University, Tehran, Iran.

mohammadi.mojtaba@wtiau.ac.ir

Zohreh Seifoori is an associate professor of applied linguistics teaching at Islamic Azad University, Science and Research Branch, Tehran. She has presented and published numerous papers in accredited national and international journals. Her research interests include teacher education, learner autonomy, and teaching methodology.

Seifoori, Z. Associate Professor, Applied Linguistics, English Department, Science and Research Branch, Islamic Azad University, Tehran, Iran.

seifoori@iaut.ac.ir

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ORIGINAL RESEARCH PAPER

Effect of Web-based Peer Assessment on Students' Self-Directed Learning Skills

***M. Bagheri*[*,1], *F. Sahraeei*[2], *M. Khanmohammadi*[2]**

[1] *Department of Educational Science, Faculty of Humanities, Arak University, Arak, Iran*
[2] *General Department of Education, Arak, Iran*

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* Corresponding author
m-bageri@araku.ac.ir
(+98918) 3682164

ABSTRACT

Background and Objectives: The changes in the new world, due to social, cultural, and the development of information and communication technologies (ICTs), have led to a modification in the objectives and educational approaches to align with the changes occurring in the learners' environment. One of the new approaches that has received attention in teaching and learning to acquire 21st-century skills is peer assessment. This study examined the impact of web-based peer assessment on the self-directed learning skills of educational sciences students at Arak University.

Materials and Methods: Researchers employed a quasi-experimental research method with a pre-test-post-test design and included a control group in the study. The target population consisted of all educational sciences students in the academic year 2022-2023 at Arak University (178 students), from which ۳۲ participants were selected through the convenience sampling method and assigned randomly into two groups: experimental and control. To gather data for the study, the researchers utilized the Self-directed Learning Readiness Questionnaire, which comprised 40 items and three subscales: self-management, desire for learning, and self-control. The questionnaire was administered before and after the course. During the 10 sessions, web-based peer assessment was integrated into the training process in the experimental group. In this way, courses, students, and the instructor were defined in the Learning Management System (LMS) of Arak University. After each teaching session, the teacher added an activity (peer assessment) in the system, in such a way that the students did homework related to the subject of the lesson. The teaching approach in both the experimental and control groups involved the teacher following a lesson plan and allowing the learners to ask questions during the teaching process. However, there was a difference in how the two groups were assessed. In the experimental group, peer assessment was utilized, where students reviewed and assessed their classmates' assignments. On the other hand, the control group followed a conventional evaluation method. In the classroom, the teacher delivered lessons and assigned homework to the students. The students needed to complete the assignments and submit them to the teacher for assessment. The teacher reviewed the student's homework in each session and provided feedback. Statistical analyses, including descriptive statistics (i.e., mean and standard deviation), as well as inferential statistics (i.e., Analysis of Covariance), were employed to analyze the data.

Findings: The findings indicated that peer assessment training had a notable impact on self-directed learning skills and their sub-scales, including self-management, desire for learning, and self-control (p<0.5).

Conclusions: Based on the findings of this research, utilizing peer assessment can serve as an effective approach to enhance students' self-directed learning abilities, a crucial skill for learners in the 21st century. However, the successful implementation of peer assessment requires certain conditions that teachers should consider. These include having an appropriate e-learning platform, the instructor's formulation of assessment criteria, and providing proper guidance to learners acting as evaluators. It is important to note that the implementation of peer assessment comes with its own set of challenges, which should be thoroughly explored in studies examining its different aspects.

NUMBER OF REFERENCES	NUMBER OF FIGURES	NUMBER OF TABLES
38	0	6

مقاله پژوهشی

تاثیر همتاارزیابی مبتنی بر وب بر مهارت های یادگیری خودراهبری دانشجویان

محسن باقری*[1]، فاطمه صحرایی[2]، مرمر خانمحمدی[2]

[1] گروه علوم تربیتی، دانشکده علوم انسانی، دانشگاه اراک، اراک، ایران
[2] اداره کل آموزش و پرورش استان مرکزی، اراک، ایران

چکیده

پیشینه و اهداف: تغییرات دنیای جدید به واسطه پیچیدگی‌های اجتماعی، فرهنگی و توسعه فناوری‌های اطلاعات و ارتباط منجر به تغییر در اهداف و رویکردهای آموزشی جهت تطابق با تغییرات ایجاد شده در محیط پیرامون یادگیرندگان شده است. از جمله رویکردهای جدید که در فرایند آموزش و یادگیری جهت ایجاد مهارت‌های قرن بیست و یکم در یادگیرندگان مورد توجه قرار گرفته است همتاارزیابی است. این مطالعه با هدف بررسی تأثیر همتاارزیابی مبتنی بر وب بر مهارت‌های یادگیری خودراهبری دانشجویان علوم تربیتی دانشگاه اراک انجام شد.

روش‌ها: محققان از روش پژوهش شبه تجربی و از طرح پیش آزمون-پس آزمون همراه با گروه گواه استفاده کردند. جامعه پژوهش کلیه دانشجویان علوم تربیتی در سال تحصیلی ۱۴۰۱-۱۴۰۲ به تعداد ۱۷۸ نفر بودند که از میان آن‌ها ۳۲ نفر به عنوان نمونه به صورت در دسترس انتخاب شدند و در دو گروه آزمایش و کنترل به صورت تصادفی توزیع شدند. جهت جمع آوری داده های مورد نیاز در این پژوهش از پرسشنامه آمادگی یادگیری خودراهبری استفاده شد. این پرسشنامه دارای ۴۰ سوال و سه زیرمقیاس خود مدیریتی، لذت از یادگیری و خود کنترلی است. پرسشنامه پیش و پس از دوره به اجرا درآمد. در گروه آزمایش به مدت ۱۰ جلسه فرایند آموزش همراه با همتاارزیابی مبتنی بر وب انجام شد. به این صورت که درس، دانشجویان و استاد درس در سامانه مدیریت دروس تعریف شدند. بعد از هر جلسه تدریس، استاد درس یک فعالیت (همتاارزیابی) در سامانه اضافه می کرد، به نحوی که دانشجویان در رابطه با موضوع درس تکلیفی را انجام می‌دادند، سپس استاد با استفاده از افزونه کارگاه آموزشی موجود در سامانه، فعالیت همتاارزیابی را اجرا می کرد. فرایند آموزش در گروه آزمایش و گواه به این صورت بود که استاد درس بر اساس طرح درس، موضوعات درسی را تدریس می‌کرد، در خلال تدریس امکان پرسش و پاسخ توسط یادگیرندگان وجود داشت. تفاوت دو گروه در بکارگیری همتاارزیابی در گروه آزمایش بود و دانشجویان تکالیف همکلاسی‌ها را مورد بررسی و ارزیابی قرار می دادند، در حالیکه در گروه گواه شیوه ارزیابی به شکل مرسوم صورت گرفت. به این صورت که مدرس در کلاس درس آموزش‌ها را ارائه می داد، سپس تکالیفی برای دانشجویان تعریف می شد. آنها موظف به انجام تکالیف و ارسال آن به مدرس بودند، مدرس هر جلسه تکالیف دانشجویان را بررسی می کرد و به آنها بازخورد می داد. جهت تحلیل داده های پژوهش از آمار توصیفی (میانگین و انحراف معیار) و آمار استنباطی (آزمون تحلیل کوواریانس) استفاده شد.

یافته‌ها: داده های پژوهش نشان داد آموزش به همراه همتاارزیابی بر مهارت‌های یادگیری خودراهبری و زیرمقیاس آن (خود مدیریتی، لذت از یادگیری، کنترل یادگیری) تاثیر معنی داری دارد($p<0.5$).

نتیجه‌گیری: با توجه به نتایج این مطالعه، روش همتاارزیابی به عنوان روشی جهت افزایش مهارت‌های یادگیری خودراهبری دانشجویان، که از مهارت‌های مورد نیاز در یادگیرندگان قرن بیست و یکم است، می تواند مورد استفاده قرار گیرد. اجرای همتاارزیابی مستلزم وجود شرایطی است که لازم است مورد توجه مدرسان قرار گیرد از جمله: پلتفرم آموزش الکترونیکی مناسب، تدوین معیارهای ارزیابی توسط مدرس و راهنمایی مناسب یادگیرندگان به عنوان ارزیاب. لازم است جنبه های مختلف چالش های اجرای همتاارزیابی در مطالعات تکمیلی مورد بررسی قرار گیرد.

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* نویسنده مسئول
m-bageri@gmail.com
۰۹۱۸-۳۶۸۲۱۶۴

Introduction

In the rapidly evolving and ever-changing world we live in today, education plays a crucial role in preparing individuals to navigate the complexities of society and adapt to emerging challenges [1]. The advancements in technology, globalization, and the interconnectedness of our world have given rise to a new paradigm of learning as lifelong learning [2]. To make learning a lifelong and high-quality experience, we need to look for solutions and processes that go beyond a particular moment in time [3]. One of the

effective solutions in education is self-directed learning [4], which enhances learners' self-confidence and ability to learn independently, particularly in challenging educational environments [5]. Correctly learned, self-directed learning provides a foundation for lifelong learning. In other words, active learning, which emphasizes the learner's role in the learning process and is highly valued in education today, is the most stable form of learning. It is now widely accepted that knowledge created by learners themselves is useful and can be applied in other learning situations [6].

Self-directed learning (SDL) was first introduced by Malcolm Knowles in 1978 [7]. In this type of learning, the learner's acquisition of knowledge surpasses that of traditional teacher-centered learning. SDL fosters learners' motivation and interest in the learning process, allowing them to retain what they learn and apply to expand their knowledge and keep up with new developments [8]. SDL is a process where individuals take the initiative, with or without assistance from others, to identify their learning needs, formulate goals, identify resources (both human and material) for learning, select appropriate learning strategies, and evaluate learning outcomes [9]. Self-directed learners are proactive and self-motivated individuals who take the initiative to learn rather than waiting passively. They engage in purposeful and meaningful learning, and their high motivation leads to stable and continuous learning. Such individuals are generally more responsible in their lives and benefit from self-discipline in their learning [10].

People with high levels of self-directed learning exhibit characteristics of active learners, such as a strong desire to learn, problem-solving skills, and the ability to engage in independent learning activities and manage their learning autonomously [11]. In this process, learners are expected to consciously take responsibility for directing their learning [12, 13]. SDL empowers individuals to pursue and learn what they need to learn. Over the past few decades, developing and fostering SDL skills has become a key goal in adult education, leading to increased research on the topic worldwide. It is possible to design and plan educational conditions in a way that fosters learners' self-directed learning skills. such as: implementing project-based and research-based methods that encourage active learner involvement [14], teaching metacognitive strategies such as goal-setting, planning, monitoring, and evaluating their learning [15], integrating technology into the teaching and learning process, providing access to diverse resources [16], promoting peer learning, and incorporating self-assessment and peer assessment [17].

Peer assessment has gained attention in recent years as a means of developing basic skills in learners [18]. In this type of assessment, learners work closely together for extended periods, providing them with opportunities to evaluate each other's work [19]. Peer assessment refers to the evaluation of the activities of other people in the group, and it can provide valuable information for feedback to the student or educational staff [20].

Peer assessment can be used to evaluate the quality of a range of products, including writing, oral presentations, portfolios, test performance, or other skilled behaviors [21]. It can be collective or formative and aims to help learners plan their learning, identify their strengths and weaknesses, develop metacognition, and improve other personal and professional skills. Peer feedback is available in greater volume and with greater urgency than teacher feedback. Even a peer evaluator with less skill in evaluation but more time to do it can create a valid assessment, which can be as valid as a teacher's assessment [22]. Indeed, peer

assessment has been shown to have a positive impact on students' independence, motivation, self-regulation, and metacognition, in addition to improving performance standards and duties [23]. The primary objective of peer assessment is to cultivate a sense of responsibility in individual and peer learning [24,25].

Review of the Related Literature

Several studies have examined how peer assessment affects the overall learning process, as discussed below.

The study conducted by Kalbasi et al. [26] examined how the utilization of peer assessment impacted the knowledge, skills, and attitudes of student teachers. The outcome of their investigation revealed that both teachers and students acknowledged the beneficial influence of this assessment method in enhancing the knowledge, attitude, and skills of students. As Vedjani and Saeedi's study showed [27] peer assessment is an effective technique that enhances students' learning across multiple educational disciplines. The authors suggested that obtaining constructive feedback through this method requires learners to acquire specific skills and knowledge beforehand to ensure accurate and valuable evaluation.

Hongli et al. [28] revealed that the advantages of incorporating peer assessment into the educational process cannot be assumed without meeting certain circumstances. The research analyzed the factors that potentially influence the effectiveness of peer assessment and identified rating as the most significant determinant. Specifically, the study found that the impact of peer assessment is more substantial when students receive training on how to assess and receive evaluator training, compared to when they do not receive such training.

Jones and Alcock [29] highlighted the importance of appropriate assessment criteria in peer assessment. They found high validity and reliability between expert evaluators and novice evaluators (students and peers), indicating that peers perform well as evaluators and have a positive impact on the learning process. Li and Geo [30] also noted the increasing integration of peer assessment into educational settings as a means of enhancing learning. They examined the use of peer assessment by students with different learning levels, including weak, average, and strong students. The results showed that students with low and medium progress had significant improvement immediately after the integration of the peer assessment model, while the model had less impact on the performance of students with high progress. Taheri and Abdollahi-Guilan [31] also highlighted the impact of peer feedback on the writing performance of language learners, specifically students learning English. They found that this type of assessment had an effective impact on learning.

Najafipour [32] conducted a study comparing self-assessment and peer assessment of the clinical ability of medical students. The researcher suggested that the assessment of students' abilities in the areas of professionalism, teamwork, and communication skills in the clinical environment should be done using a range of evaluators, including instructors, peers, and the learners themselves. The study concluded that self-assessment and peer assessment are complementary, applicable, accessible, and useful methods for evaluating students' achievement of expected capabilities in the education evaluation system.

Spiller [33] identified peer assessment as a useful way to acquire and improve critical assessment skills. The author suggested that through suggestions for the work of other

learners, giving and receiving immediate and relevant feedback from one or more classmates, and understanding learners' learning strengths and weaknesses, peer assessment can enhance evaluation skills. In a qualitative study conducted by Egan and Costello [34], students' experiences with peer assessment were examined. The findings indicated that students believed that the opportunities provided by conducting peer assessment led to an increase in a range of skills, including assessment, communication skills, and self-reflection skills.

In Birtland's [35] study, the primary objective was to investigate the influence of peer-supported e-portfolios on the enhancement of learners' self-directed learning abilities. The results indicated that when learners actively participate in giving and receiving feedback within electronic portfolios, they not only receive assistance from their peers during the learning journey but also contribute to their classmates' comprehension of various concepts. As a result, this collaborative approach significantly enriched their self-directed learning skills.

In the rapidly evolving new world, students need to acquire a diverse set of skills to thrive and succeed. These skills go beyond traditional academic knowledge and focus on equipping students with the abilities necessary to navigate an increasingly complex and interconnected global society. Conventional teaching methodologies have long been the norm in education, with a focus on teacher-led instruction and a structured curriculum. However, in today's rapidly changing world, this traditional approach often falls short of supporting students' self-directed learning.

It is true that in Bloom's Taxonomy, evaluation is considered a high-level educational objective that builds upon lower-level objectives such as understanding, applying, analyzing, and synthesizing. Traditional methods of teaching and assessment are often unable to meet the high-level learning goals required in today's society. While traditional methods have played a crucial role in shaping our understanding of the world, they have inherent limitations that hinder the attainment of advanced knowledge and skills. In this era of innovation and progress, it has become evident that relying solely on conventional approaches to learning is insufficient. To truly achieve high-level learning goals, we must explore alternative methods and embrace the transformative power of modern educational techniques. Peer assessment has been shown to improve high-level skills in learners such as critical thinking, questioning, and analysis, which can promote the development of self-directed learning skills. In the 21st century, self-directed learning is becoming an increasingly important skill for learners to develop.

Despite the growing body of research on peer assessment, it has received little attention in higher education in Iran. However, the impact of the peer assessment method on self-directed learning skills needs to be investigated further. Therefore, this study aims to investigate the effect of peer assessment on students' self-directed learning skills. By conducting this type of research, more insights can be gained into how this method can be used to promote independent learning among students. This can have important implications for the design and implementation of educational programs in Iran, as well as for the development of policies and practices related to assessment and evaluation in higher education. Overall, exploring the potential of peer assessment to promote self-directed learning skills in the context of Iranian higher education can contribute to the ongoing efforts to enhance the quality of education and support the development of 21st-century skills among students.

Method

The present study utilized a quasi-experimental design with a pre-test-post-test format and a control group. The statistical population consisted of all educational science students enrolled in Arak University during the 1400-1401 academic year (178 students). The sample consisted of 32 students enrolled in Programming Course, with 16 students randomly assigned to the experimental and control groups. The experimental group received the peer assessment method, while the control group received conventional training and evaluation methods.

To collect data on self-directed learning readiness, Fisher et al.'s [36] Self-directed Learning Readiness Questionnaire was utilized. This questionnaire comprises 40 items and employs a five-point Likert scale to assess self-directed learning readiness in three domains: self-control (15 items), desire for learning (13 items), and self-management (12 items). Since Fisher et al., developed and implemented the readiness scale for self-directed learning in Australia for English speakers, Nadi and Sajjadian [37] translated and standardized the questionnaire for Iranian sample. Fisher et al.'s findings in Australia demonstrated that the overall reliability of this instrument via Cronbach's alpha method was found to be 0.83, while it was 0.87 for the self-management subscale, 0.85 for desire for learning at, and 0.80 for self-control. The item-total correlation ranged from 0.26 to 0.84. Additionally, the validity of this scale was established through construct validity and confirmatory factor analysis. In Nadi and Sajjadian's study, Cronbach's alpha method was used to assess the reliability of the scale, which yielded 0.82 for the whole test, 0.78 for the self-management subscale, 0.71 for the desire for learning, and 0.60 for self-control.

This research was implemented in the context of a Programming Course from early September 2022 to December 2022,. The experimental group was exposed to peer assessment, while the control group received conventional teaching and evaluation methods. In both the experimental and control groups, the teaching method consisted of the teacher adhering to a predetermined lesson plan while encouraging learners to ask questions. Nevertheless, the groups differed in terms of their assessment methods. The Arak University Learning Management System (LMS) was employed for peer assessment. Courses, students, and the isntructor were defined in the system. Following each teaching session, the instructor added an activity (peer assessment) to the system. Students completed homework related to the lesson's subject, and then the instructor utilized the workshop extension in the LMS system to conduct the peer assessment activity. The peer assessment process consisted of five stages: 1) the instructor reviewed and verified assignments, 2) the instructor established assessment criteria and communicated them to students, 3) assignments were randomly and anonymously sent to three classmates for assessment, 4) classmates evaluated assignments based on the established criteria, and 5) feedback on evaluated assignments was provided to the person who submitted the assignment. Table (1) displays the topics of the lessons.

The control group received conventional evaluation methods, where the instructor presented lessons in the classroom, assigned homework to the students, and required them to submit their completed assignments. The teacher reviewed the students' homework every session and provided feedback.

Table 1: Topic of the lesson

Sessions	Topics
First session	Getting to know basic HTML tags
Second session	How to insert sound, image, and video in HTML environment
Third session	Familiarity with internal and external CSS
Fourth session	How to create links
Fifth session	How to design menus, buttons, and templates
Sixth session	Designing tables
Seventh session	Getting to know the concepts of margin and padding
Eighth session	Getting to know the basics of educational websites

Results and Findings

To analyze the data collected in this study, descriptive statistics such as mean and standard deviation, as well as inferential statistics like Multivariate Analysis of Covariance, were employed. All analyses were conducted using SPSS 23. Table 2 displays the descriptive statistics, including the mean and standard deviation, for both the experimental and control groups.

Table 2 shows that the mean scores in the experimental and control groups in the pre-test of self-directed learning skills in general and in its subscales including self-control, learning enjoyment, and self-management are almost similar to each other, while the means of the two groups after the implementation of the training course are different. To analyze the data, Multivariate Analysis of Covariance was used. At first the assumptions such as the normal distribution of the data, and the homogeneity of the variances were examined. The results are presented in Tables 3 and 4.

As can be seen in Table 3, considering that the significance level of the numbers is greater than 0.05, it can be said that the data is normally distributed.

Table 3: Test of normality for self-directed learning skill and its subscales.

Pre and post-test	F	N	Sig.
SDL	2.98	32	0.09
Self-management	3.66	32	0.07
Desire for learning	0.494	32	0.486
Self-control	0.266	32	0.609

Table 2: Descriptive statistics of self-directed learning readiness scores and its sub-components by group

Variable	Test	Group	N	Mean	SD
Self-directed learning	Pre-test	Experimental	16	124.4	6.20
		Control	16	128	6.58
	Post-test	Experimental	16	136.4	4.89
		Control	16	123.4	6.63
Self-management	Pre-test	Experimental	16	45.63	3.99
		Control	16	49.59	3.92
	Post-test	Experimental	16	51.22	2.94
		Control	16	46.40	5.23
Desire for learning	Pre-test	Experimental	16	40.90	3.96
		Control	16	39.45	4.17
	Post-test	Experimental	16	42.18	3.23
		Control	16	39.50	3.63
Self-control	Pre-test	Experimental	16	37.86	3.22
		Control	16	38.95	3.98
	Post-test	Experimental	16	42.77	3.18
		Control	16	38.36	3.25

Table 4: Levine's test related to the homogeneity of variances in self-directed learning skills and its subscales

Pre and post-tests	Statistics	N	Sig.
Pre-test of SDL	0.970	32	0.294
Post-test of SDL	0.964	32	0.189
Pre-test of self-management	0.952	32	0.064
Post-test of self-management	0.959	32	0.115
Pre-test of desire for learning	0.974	32	0.423
Post-test of desire for learning	0.954	32	0.076
Pre-test of self-control	0.966	32	0.214
Post-test of self-control	0.961	32	0.142

Based on Table 4, it can be seen that all p values are greater than 0.05. Therefore, it can be said that the variance of the two groups is similar in all variables. Considering the confirmation of the assumptions related to the Multivariate Analysis of Covariance, this test can be used in data analysis. Below are the results:

Table 6 shows that after controlling the effect of the pre-tests, the group effect had a significant effect on the dependent variables, in other words, in the self-directed learning skill and its subscales, including self-management, learning enjoyment, and self-control, the difference between the experimental and control groups is signifcant (p>0.05).

Discussion

Developing independent learners who do not always rely on their teachers is a crucial aim of education. Self-directed learners are active, spontaneous, and take the initiative to learn. They do not wait passively for learning opportunities to come their way. Their learning is purposeful, meaningful, and driven by high motivation, making it stable and continuous. They are responsible individuals who practice self-discipline in their learning. The results of this study demonstrate a positive and significant effect of peer assessment on the self-directed learning skills of students.

Peer assessment is an interactive assessment method of the learners that can promote self-directed learning. When used appropriately, peer assessment can be a useful tool for improving students' self-efficacy, self-management, independence in learning, and even yield positive learning outcomes. The components of self-directed learning, such as independence in learning and the desire to manage learning autonomously, align with the use of peer assessment. Breed [38] suggested that the structure of group work activities significantly impacts various aspects of self-directed learning, such as assessment, monitoring of learning, interpersonal skills, and preparation for self-directed learning. Therefore, peer assessment can be an effective tool to promote self-directed learning.

Table 5: Multivariate tests of dependent variables

Pre and post-test	Value	Hypothesis df	Error df	Sig
Pillai's Trace	0.689	3	25	0.001
Wills' Lambda	0.311	3	25	0.001
Hotellings' Trace	2.210	3	25	0.001
Roy's Largest Root	2.210	3	25	0.001

Table 6: Results of Multivariate Analysis of Covariance to examine dependent variables

Source	Value	Type III Sum of Squares	df	Mean Square	F	Sig
Group	Post-test of SDL	1239.648	1	1239.648	33.45	0.001
	Post-test of self-management	114.059	1	114.059	5.97	0.02
	Post-test of desire for learning	76.43	1	76.43	5.12	0.03
	Post-test of self-control	294.20	1	294.20	35.16	0.001

The results of this study are consistent with Villarreal's [23] research, which indicates that peer assessment has a positive impact on students' autonomy, motivation, self-regulation, and metacognition. Additionally, the study by Egan and Costello [34] on the effects of peer assessment on communication and self-reflection skills, as well as Najafipour's [32] research on the benefits of peer assessment for independent learning, teamwork, and communication skills, are in agreement with these findings. The outcomes of this study align with Spiller's [33], and Jones and Alcock's research, indicating that peer assessment has a favorable impact on self-directed learning skills, leading to independent and profound learning. Furthermore, the study results of Kalbasi et al. [26] and Taheri and Abdullahi-Gulan [31] support this notion, indicating that peer assessment contributes to learning and knowledge enhancement. In addition, Hongli and Xiong [28], and Vejdani and Saeedi [27] highlight the importance of providing training for evaluators before conducting peer assessment, as this can be beneficial in the successful implementation of such projects. Their research results also emphasize the impact of peer assessment on independent learning. Peer assessment has emerged as a powerful tool in promoting the development of self-directed learning skills among students. Through the process of evaluating and providing feedback to their peers, students not only enhance their understanding of the subject matter but also cultivate critical thinking, self-reflection, and self-regulation abilities. The act of assessing their peers' work requires students to assume a more active role in their learning journey, as they must analyze, evaluate, and provide constructive feedback based on established criteria. This engagement fosters a sense of ownership and responsibility for their learning, empowering them to take charge of their educational experiences. Moreover, peer assessment offers students the opportunity to refine their metacognitive skills, as they reflect on their work in light of the feedback received from their peers. This process enhances their ability to set goals, monitor progress, and adapt their learning strategies accordingly. As students become more self-directed in their learning, they develop a sense of autonomy and agency, enabling them to navigate complex challenges and pursue learning beyond the confines of the classroom.

Conclusions

This study aimed to examine how peer assessment affects students' self-directed learning. The results suggest that peer assessment has a noteworthy effect on the self-directed skills of students. In conclusion, peer assessment plays a pivotal role in fostering self-directed learning skills among students. By engaging in the evaluation of their peers' work, students develop critical thinking, collaboration, and metacognitive abilities, empowering them to take ownership of their learning journey. As educators continue to integrate peer assessment into their

pedagogical practices, they provide students with a valuable tool to cultivate lifelong learning skills and thrive in an ever-changing world.

It is important to acknowledge the limitations of research studies, particularly in the context of peer assessment and self-directed learning. Several limitations can be identified, with one significant limitation being the lack of generalizability of the results. This study was conducted in the Department of Educational Sciences at Arak University in Iran, with a limited sample size. Consequently, the findings may not be applicable to a broader population or diverse contexts. The characteristics and demographics of the participants, as well as the specific instructional methods employed, can vary widely, making it challenging to generalize the results to other educational settings or student populations.

Additionally, research in this area often relies on self-report measures or subjective assessments, which can introduce biases and limitations. Students' perceptions of their self-directed learning skills or the effectiveness of peer assessment may not always align with their actual behaviors or outcomes. Objective measures, such as standardized tests or independent evaluations, could provide a more comprehensive and reliable assessment of the impact of peer assessment on self-directed learning skills. Furthermore, longitudinal studies that track students' progress over an extended period are relatively scarce in the field of peer assessment and self-directed learning. The long-term effects of peer assessment on self-directed learning skills, including its sustainability and transferability to real-life situations, remain relatively unexplored. Longitudinal research designs would provide valuable insights into the durability and practical implications of incorporating peer assessment into educational practices.

Authors' Contribution

In this study, the first author prepared the research design and wrote the manuscript. The second author was responsible for collecting data, and the third author was involved in the implementation and analysis of data.

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Conflicts of Interest

The authors declare that they have no conflict of interest.

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AUTHOR(S) BIOSKETCHES

Mohsen Bagheri is an assistant professor in the Faculty of Educational Sciences, Educational Technology, Arak University. His research interests include e-learning, education based on new technologies, gamification, new teaching methods, measurement and evaluation.

Bagheri, M. Asisstant Professor, Department of Educational Science, Faculty of Humanities, Arak University, Arak, Iran

M-bageri@araku.ac.

Fatemeh Sahrai has a master's degree in Educational Technology from Arak University. She is a primary school teacher and her fields of study are educational design, learning theories, educational media.

Sahraeei, F. MA of Educational Technology, Primary School Teacher, General Department of Education, Arak, Iran

fatemesahraei@yahoo.com

Marmar Khanmohammadi has a PHD in Philosophy of Education. Currently, she is a primary school teacher. Her study interests are philosophy for children, active methods of teaching and learning, philosophical theories in education

Khanmohammadi, M. PhD. of Educational Technology, Primary School Teacher, General Department of Education, Arak, Iran

marmar96kh@gmail.com

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ORIGINAL RESEARCH PAPER

Assessing Prospective Teachers' Geometric Transformations Thinking: A Van Hiele Theory-Based Analysis with Eye Tracking Cognitive Science Method

***M. Ghorbani*[*,1], *F. S. Izadi*[1], *S. S. Roshan*[2], *R. Ebrahimpour*[2,3]**

[1]*Department of Mathematics, Faculty of Science, Shahid Rajaee Teacher Training University, Tehran, Iran*
[2]*Department of Artificial Intelligence, Faculty of Computer Engineering, Shahid Rajaee Teacher Training University, Tehran, Iran*
[3]*Center for Cognitive Science, Institute for Convergence Science and Technology, Sharif University of Technology, Tehran, Iran*

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* Corresponding author
mghorbani@sru.ac.ir
(+9821) 22970029

ABSTRACT

Background and Objectives: Geometric transformations have played a crucial role throughout history in various aspects of human life. Symmetry is one of the important concepts in school mathematics. Students' academic performance is intricately connected to the knowledge and skills of their educators. Recognizing the importance of prospective teachers (PTs) as future educators, in the initial stage, the aim of this research is to assess and analyze the levels of geometric thinking among prospective elementary teachers (PETs) utilizing Van Hiele's theory. Subsequently, the research seeks to delve into the thinking process and gaze patterns of prospective mathematics education teachers (PMETs) using the cognitive science method of eye tracking.

Materials and Methods: This study focuses on investigating and evaluating the thinking of geometric transformations and problem-solving skills among prospective teachers (PTs). The research method employed a combined survey method, encompassing two distinct tests conducted on two groups of PTs. The accessible statistical sample includes 50 participating PETs and 21 participating PEMTs from Iran. The PETs of Farhangian University of Isfahan were divided into two groups: 42 students who had not learned the concept of geometric transformations in their undergraduate program (NPGT), and 8 students who had learned this concept in their undergraduate program (PGT). To assess the level of geometric thinking among participants, a self-made geometric test based on Van Hiele's theory was utilized. The test reliability was assessed using Cronbach's alpha coefficient, which yielded a value of 0.68. Additionally, the validity of the test has been confirmed by some professors. In evaluating geometric thinking, a cognitive science method was performed. This method involved designing a psychophysical experiment and recording eye movements of the PMETs. The psychophysical experiment part was conducted in the computer laboratory of Shahid Rajaee Teacher Training University, Tehran, and was performed by Eyelink device and MATLAB software on student teachers of mathematics education of this university.

Findings: The results of the research show that students recognize the shape with symmetry as a symmetrical shape, but they perform poorly in determining the type of symmetry of symmetrical shapes, especially when a shape has rotational symmetry or oblique axial symmetry or a combination of several types of symmetry. In the first stage, the evaluation of PETs responses showed that 34% of them were in the first level and 18% in the second level of Van Hiele. The cognitive findings revealed that PMETs demonstrated superior performance in recognizing symmetries characterized by a single type of symmetry, in contrast to shapes involving combinations of various symmetries. Examining the recorded eye-tracking images of the students revealed a difference in gaze patterns between the groups that gave correct and incorrect answers. In addition, this difference is also evident among images with different symmetries (reflection, central, rotational).

Conclusions: The current research confirms the weakness of students in identifying the type of symmetry in symmetrical shapes. It also emphasizes the need to pay more attention to the training of PTs during their academic years. To address this, it is suggested to revise the curriculum concerning geometric transformations in the university courses for PTs training, additionally, the utilization of software such as Augmented Reality (AR) and GeoGebra can contribute to enhancing cognitive and visual abilities of PTs in comprehending the concept of symmetry.

NUMBER OF REFERENCES	NUMBER OF FIGURES	NUMBER OF TABLES
64	11	8

مقاله پژوهشی

ارزیابی تفکر تبدیلات هندسی دانشجو معلمان: تحلیل مبتنی بر نظریه ون هیلی با استفاده از روش علوم شناختیِ ردیاب چشم

مجتبی قربانی [*۱،۲]، فاطمه سادات ایزدی[۱]، ستاره سادات روشن[۲]، رضا ابراهیم‌پور [۲،۳]

[۱] گروه ریاضی، دانشکده علوم پایه، دانشگاه تربیت دبیر شهید رجائی، تهران، ایران

[۲] گروه هوش مصنوعی، دانشکده مهندسی کامپیوتر، دانشگاه تربیت دبیر شهید رجائی، تهران، ایران

[۳] مرکز علوم شناختی، پژوهشکده جامع علوم و فناوری‌های همگرا، دانشگاه صنعتی شریف، تهران، ایران

چکیده

پیشینه و اهداف: تبدیلات هندسی در طول تاریخ نقش مهمی در جنبه‌های مختلف زندگی بشر داشته‌اند. تقارن یکی از مفاهیم مهم در ریاضیات مدرسه است. واضح است که عملکرد تحصیلی دانش‌آموزان به طور پیچیده‌ای با دانش و مهارت‌های مربیان آن‌ها مرتبط است. با توجه به اهمیت نقش دانشجو معلمان به عنوان مربیان آینده، در مرحله اول، هدف این تحقیق بررسی و ارزیابی سطوح تفکر تبدیلات هندسی در بین دانشجو معلمان ابتدایی بر اساس نظریه یادگیری ون هیلی است. پس از آن، این تحقیق به دنبال بررسی فرآیند تفکر و ارزیابی الگوهای نگاه دانشجو معلمان آموزش ریاضی به عنوان گروه متخصص، با استفاده از روش علوم شناختیِ ردیاب چشم است.

روش‌ها: این مطالعه به بررسی و ارزیابی تفکر تبدیلات هندسی و مهارت‌های حل مسئله در میان دانشجو معلمان متمرکز است. روش تحقیق مورد استفاده پیمایشی آمیخته است. نمونه آماری در دسترس شامل ۵۰ دانشجو معلم ابتدایی و ۲۱ دانشجو معلم آموزش ریاضی ایرانی است. دانشجو معلمان ابتدایی از دانشگاه فرهنگیان اصفهان انتخاب شده و به دو گروه شامل ۴۲ نفر از دانشجویانی که مفهوم تبدیلات هندسی را در مقطع کارشناسی نیاموخته بودند و ۸ نفر از دانشجویانی که این مفهوم را در مقطع کارشناسی آموخته بودند، تقسیم شدند. برای بررسی سطح تفکر هندسی شرکت‌کنندگان، از آزمونی محقق ساخته بر اساس نظریه ون هیلی استفاده شد. پایایی آزمون با استفاده از ضریب آلفای کرونباخ ارزیابی شد که مقدار ۰.۶۸ بدست آمد. روایی آزمون نیز توسط اساتید مورد تایید قرار گرفت. در ارزیابی تفکر هندسی، یکی از روش‌های علوم شناختی به کار گرفته شد. این روش شامل طراحی آزمون روان-فیزیک همراه ثبت حرکات چشم در گروه دانشجو معلمان آموزش ریاضی بود. آزمون روان-فیزیک در آزمایشگاه کامپیوتر دانشگاه تربیت معلم شهید رجایی تهران با دستگاه Eyelink و نرم افزار MATLAB بر روی دانشجو معلمان آموزش ریاضی این دانشگاه، انجام شد.

یافته‌ها: یافته‌های تحقیق نشان داد که دانشجویان، شکل با تقارن را به عنوان شکل متقارن تشخیص می‌دهند، اما در تعیین نوع تقارن اشکال متقارن عملکرد ضعیفی دارند، به ویژه زمانی که یک شکل دارای تقارن چرخشی یا تقارن محوری مایل یا ترکیبی از چندین نوع تقارن باشد. ۳۴٪ از دانشجو معلمان آموزش ابتدایی در سطح اول و ۱۸٪ در سطح دوم نظریه ون هیلی قرار گرفتند. یافته‌های شناختی نشان داد که دانشجو معلمان آموزش ریاضی در تشخیص اشکال متقارنی که با یک نوع تقارن مشخص شده‌اند نسبت به شکل‌هایی که شامل ترکیبی از تقارن‌های مختلف هستند، عملکرد نسبتا موفق‌تری داشته‌اند. بررسی تصاویر ثبت‌شده ردیابی چشم دانشجویان، تمایزی را در الگوهای نگاه، بین گروه‌هایی که پاسخ‌های درست و نادرست در ارائه می‌دادند، نشان داد. علاوه بر این، این تفاوت در بین تصاویر با تقارن‌های مختلف(خطی، مرکزی، چرخشی) نیز مشهود است.

نتیجه‌گیری: پژوهش حاضر ضعف دانشجو معلمان در شناسایی نوع تقارن در اشکال را تائید می‌کند. همچنین بر نیاز به توجه بیشتر به امور برای رسیدگی به این موضوع، پیشنهاد می‌شود که برنامه درسی مربوط به تبدیلات هندسی در دوره آموزشی دانشگاه دانشجو معلمان مورد بازنگری قرار گیرد. علاوه بر این، استفاده از نرم‌افزارهایی مانند واقعیت افزوده و جئوجبرا می‌تواند به افزایش توانایی‌های شناختی و بصری دانشجو معلمان در درک و تشخیص مفهوم تقارن کمک کند.

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علوم شناختی

* نویسنده مسئول
mghorbani@sru.ac.ir
۰۲۱-۲۲۹۷۰۰۲۹

Introduction

Mathematics application in real-life situations is an essential aspect of the subject, and geometric transformations represent one of its most significant applications. Symmetry, as a key concept in geometry and the foundational principle of mathematical concepts [1], is a fundamental part of geometry and nature, creating patterns that help us conceptually organize our world [2]. The concept of symmetry is the one that humans can intuitively recognize [3]. It is often linked with aesthetic beauty and can be observed in both natural phenomena and human-made objects, such as artworks and manufactured products, across the globe [4]. It is widely acknowledged that symmetry is a crucial element in beauty in art and design. For instance, the Birkhoff aesthetic measure, developed in two probabilistic and sequential dimensions, accurately evaluates symmetry in designs and artistic effects. This measure is based on the principles of harmony, balance, simplicity, and complexity, and aims to capture subjective beauty experiences in objective terms [5]. Symmetry also enables students to visualize various geometric concepts and relate them to real-life experiences [6]. Moreover, it provides many opportunities for interdisciplinary reinforcement [7]. Therefore, symmetry is one of the most significant mathematics applications. The concept of geometric transformation is easy to grasp, and it can be illustrated through many real-world examples [8], making it crucial to teach it in elementary schools [2]. Mathematics teachers emphasize the need for students to acquire this concept at a young age [9]. Research in this field has highlighted common misconceptions among students, including their difficulty in distinguishing between axial and central symmetry [10, 11].

The background of this research suggests known issues with teaching the concepts of symmetry, rotation, translation, and geometric transformations in general in elementary and high schools [12]. In a study conducted by Zaslavsky [13], it was revealed that students' challenges in understanding symmetry are closely linked to teachers' misconceptions about symmetry. According to research, the symmetry and rotation skills of prospective elementary mathematics teachers have a significant impact on their ability to teach mathematical concepts effectively [14]. Specifically, teachers with a deep understanding of symmetry and rotation are more likely to:

- Help their students gain strong spatial reasoning skills: Spatial reasoning is essential for understanding mathematical concepts. Teachers who can help their students develop strong symmetry and rotation skills can also help them develop their spatial reasoning abilities.
- Help their students make connections between different mathematical concepts: Symmetry and rotation are closely related to other mathematical concepts, such as geometry and algebra. Teachers who understand these concepts can help their students make connections between different mathematics topics.
- Use visual aids effectively: Symmetry and rotation are visual concepts that can be easily demonstrated through diagrams and other visual aids. Teachers with strong symmetry and rotation skills can use these tools effectively to help their students understand complex mathematical ideas.

In summary, symmetry and rotation skills help students develop strong spatial reasoning skills. This includes making connections between different mathematical concepts and using visual aids effectively.

As reported by Reyhani et al. [15] undergraduate geometry courses may not adequately equip students with the knowledge necessary for effective geometry teaching in high school. Therefore, considering the importance and necessity of the concept of symmetry, and the belief that teachers play an essential role in presenting quality mathematics to students, teachers need to know the mathematical structure of symmetry.

Providing training for elementary school teachers, especially during their teacher education program, is of critical importance. When something is taught to a teacher, a certain level of proficiency can be expected. Therefore, any shortcomings in elementary school teachers' training, especially during their teacher training program, will inevitably result in irreparable damages.

Given that most of research related to geometry emphasizes the weakness of students in geometry and has not paid attention to the root of this weakness, which mostly dates back to elementary school [16], and previous literature review has not shown similar studies in Iran, this study aims to evaluate the geometric thinking of PETs at the first two levels of the van Hiele, focusing on the topic of geometric transformations. The Van Hiele theory describes geometric thinking, consisting of five stages: Visualization, Analysis, Abstraction, Deduction, and Rigor [17, 18]. As the fourth and fifth levels of this theory extend beyond PETs knowledge and the topics covered in elementary school textbooks, they are not evaluated in this research.

Today, cognitive science is important as an interdisciplinary knowledge, and with the advancement of technology, appropriate tools and methods have been provided in this field that can be used without the direct involvement of the sample in behavioral and cognitive research [19]. Part of the current research relies on the eye movement detection tool, which is one of the tools used in cognitive science [20].

The aim of this study is to identify the geometric thinking of PETs in performing tasks related to geometric transformations, including reflection symmetry, central symmetry, and rotational symmetry. In this regard, a framework based on Van Hiele levels is used to evaluate problem-solving processes, and the main goal is to determine the skill level at which PETs solve geometric transformation problems. In addition, this study focuses on examining participants' eye movements and uses eye tracking tools to examine their performance in identifying types of symmetry and selecting symmetrical shapes. The current research seeks to answer the following research questions:

- What is the performance of PETs in providing answers evaluated at the first and second levels of Van Hiele?
- Have curriculum changes in elementary education at the undergraduate level improved PETs' geometric transformation thinking levels?
- How is the cognitive performance of PMETs in selecting symmetrical images?
- Is there a significant difference between visually recorded images of correct and incorrect PMETs responses?

Review of the Related Literature

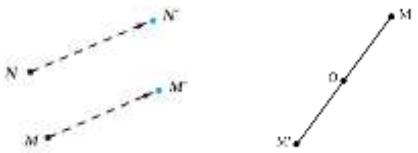
Theoretical foundations and research literature in the fields of mathematics education and cognitive sciences are explained as follows.

Theoretical foundations

Geometric transformations

Geometric transformations were first introduced in a seminar entitled “The Erlangen Program by Christian Felix Klein” in 1872. Klein defined geometry as objects whose properties

remain constant under transformations [25]. In Dodge's study [26], a transformation in a plane is defined as a one-to-one correspondence from a plane to itself. Suppose that each point N on the plane is displaced to a new position N´ within the same plane. In this scenario, N´ is deemed as the image of N, whereas N is acknowledged as the preimage of N´. In a plane, such as P, a transformation T is a function such that every point M of P corresponds to exactly a point M´ in the same plane, with the property that T(M)=M´ (Figure 1. (a)). A one-to-one correspondence of the plane onto itself is established if only distinct points have distinct images, and each point within the plane has a unique preimage point. This process is referred to as a transformation of the plane [27, 28].



(a) (b)

Fig. 1: (a) Transformation of the Plane. (b) The point M´ is the symmetric point of M.

A transformation that moves an object from one space to another without changing its size or shape is called a translation [29].

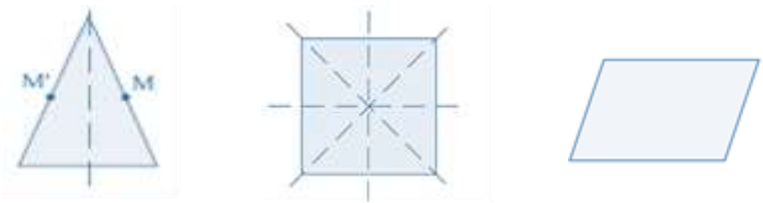
Symmetry

Symmetry of an object refers to the rigid motion (that is, a motion that preserves distance and size) of a plane that does not alter the object [30]. Geometric transformations define symmetry as an isometry. Aksoy et al. [9] describe symmetry as the positioning of a geometric figure or mathematical object in the same or different plane or space while maintaining its nature and characteristics under reflection, rotation, and translational movements. They outline the fundamental components of the symmetry concept, which require the following conditions: 1) the existence of a geometric or mathematical object, 2) performing reflection, rotation, and translational movements on the object, and 3) positioning a version of the original object in a new plane or space that remains unchanged.

According to Long et al. [27], a plane shape exhibits symmetry if any rigid motion of the plane relocates all the points within the shape back to their original points. On the other hand, a transformation of the plane is deemed as a rigid motion when and only when the distance between any two points N and M equals the distance between their respective images' points N´ and M´. In other words, NM = N´M´ holds for all points N and M, as shown in Figure 1. Rigid motions are alternatively referred to as isometries, which means "same measure" in that iso denotes "same" and metric denotes "measure".

Reflection symmetry

As described by Long [27], reflections or flips are classified as one of the four fundamental rigid motions of the plane. Specifically, in a reflection, all points M are moved to their mirror images M´, which are located on the opposite side of a given line while maintaining the same distance from that line (Figure 2).



(a) (b) (c)

Fig. 2: Plane figures and their lines of symmetry. (a)Isosceles triangle:1 line, (b)Square: 4 lines, (c) Parallelogram: no lines of symmetry.

Rotational symmetry

A rotation or a turn is classified as one of the four essential rigid motions of the plane. In a rotation, one specified point acts as the center of rotation, and the other points within the plane are turned or spun around the center at the same angle and direction. This action constitutes a transformation of the plane that upholds both the distances between the points as well as the angles between lines or segments [27].

A figure exhibits rotational symmetry if it can be rotated by an angle between 0° and 360° such that it remains unchanged. Fig. 3 shows an investigation of rotation symmetry for an equilateral triangle. The triangle undergoes a counterclockwise rotation third of a complete revolution in Fig. 3. It is also possible to achieve a matching image through a rotation two-thirds of a complete revolution or a full 360° rotation. Any figure can be rotated completely around any point as the center of rotation to yield a matching image. Figures that only produce an identical image with a full 360° rotation do not exhibit rotational symmetry [31].

Central symmetry

Central symmetry in a two-dimensional plane, also referred to as point symmetry or point reflection, constitutes a distinctive occurrence of rotation within the plane, spanning 180° around a central point. Additionally, it can be formed through the combination of two axial symmetries characterized by mutually perpendicular axes [32]. The central symmetry can be defined with a specific point O in a plane. A transformation that maps any point M to its mirror image with respect to point O is referred to as central symmetry or the center of the turn (see Figure 1. (b)). Therefore, point O is the center of this symmetry, as discussed by [33]. It is imperative to note that central symmetry in a plane is a special case of rotation, which involves rotating the figure 180 degrees around a center point, resulting in its image being an exact reflection of the original [32].

Van Hiele's theory

Pierre-Marie van Hiele (1909-2010) and Dina van Hiele Godolf (1911-1985), who served as math teachers in Montessori schools in the Netherlands, are known for developing a framework aimed at enhancing geometric reasoning. Van Hiele's theory proposes that by facilitating specific educational experiences, the learner can progress through five discrete levels that rely on successful acquisition at each stage [34]. As Reyhani has stated, this theory outlines the different stages of geometric thinking students pass through. It begins with basic recognition and ends with a precise and structured geometric proof [15]. Meanwhile, the literature [35] describes Van Hiele surfaces' distinctive characteristics in geometric transformation contexts, as given in Table 1.

Cognitive Science

The expression Cognitive Science was first used by Christopher Longuet Higgins (1973), a scholar who moved from Chemistry and Theoretical Physics to Artificial Intelligence (AI) [36]. In 1967 he founded a Machine Intelligence and Perception Department in Edinburgh, where he pursued artificial vision. He also created a group of psychologists, linguists, and neuroscientists who worked on interdisciplinary projects. He considered AI a sort of 'theoretical psychology' [36] and became a professor of Experimental Psychology. He aimed to uncover fundamental principles of human cognition, understanding, and perception. His pioneering ideas laid the groundwork for a more profound exploration of the human mind, unlocking new avenues for research within Cognitive Science [37].

Fig. 3: Rotation symmetry for an equilateral triangle.

Table 1: Van Hiele surfaces' distinctive characteristics in geometric transformation.

Levels	Characteristics: The student …
Level 1	○ identifies transformations by changes in shape; (a) in simple drawings of shapes and images; and (b) in real-life applications images. ○ discerns alteration through actual movement; names, and distinguishes transformations. ○ uses both standard and non-standard labels and names to describe transformations. ○ relies on changing shapes or movements to solve problems instead of using properties of transformations.
Level 2	○ uses attributes of transformations to draw an image or pre-image of a specific transformation. ○ identifies the properties of shape changes resulting from a specific transformation. ○ uses appropriate terminology to describe the properties and transformations involved in geometric thinking. ○ capable of finding the axis of reflection, translation vector, center of rotation, and center of enlargement. ○ correlates transformations using coordinates. ○ applies the well-known properties of geometric transformations to solve problems.
Level 3	○ carries out a combination of simple transformations. ○ explains changes to states (pre-image, image) resulting from composite transformations. ○ student illustrates transformations through the use of coordinates and matrices. ○ correlates the characteristics of transformations with modifications to a shape. ○ can name a transformation based on the initial and final states. ○ given the initial and final states, capable of decomposing and recombining a transformation into a series of simpler transformations.
Level 4	○ provides geometric proofs using a transformation-based method. ○ proves using the coordinates and matrices. ○ demonstrates their ability to solve multi-step problems and provide justifications for their solutions.
Level 5	○ knows the role that the associative, commutative, inverse, and identity properties play in composite transformation operations. ○ recognizes groups of transformations. ○ proves or disproves the subgroups of transformations from group structures.

Cognitive science is an interdisciplinary field of study that focuses on the systematic investigation of cognitive and mental processes in humans and other organisms [38]. It examines and analyzes issues related to perception, thinking, memory, language, visualization, and other cognitive functions. Cognitive science employs various methods and tools, such as experimental psychology, neuroscience, artificial intelligence, linguistics, and the philosophy of mind, to better understand and explain human cognitive processes [39, 40].

Eye Movement

Cognition, as a branch of cognitive sciences,

examines the mental processes of humans and their decision-making [41]. The use of cognitive science methods, including eye-tracking tools, enables us to closely investigate human performance in recognizing and selecting symmetrical shapes [19].

Human vision is an active and dynamic process in which the viewer actively seeks specific visual input to support ongoing cognitive and behavioral activities [42, 43]. Eye movements play a crucial role in representing the processing activities of the human mind, including image scanning and cognitive visual-motor activity analysis [44].

For the analysis of the gathered data, it is vital to first establish the definitions of the eye movement indicators presented in the following Table**.**

Table 2: Summary of key terms

Terms	Description
Fixation	is a brief period during which the eye stops at a fixed point in the visual field [45].
Saccades	Rapid eye movements occur as the gaze moves between different fixation points.
Scan paths	Gaze positions and eye movements are plotted on the stimulus image [46].
Heat map	Gaze positions are plotted on the fixation areas [46].

Related studies

Philosophers and mathematicians have studied symmetry since ancient times [47]. Symmetry has been a significant concept throughout history, and it gained a central role in shaping the scientific vision of the world during the scientific revolution of the 16th century [48]. Symmetry plays a significant role in mathematics and the natural sciences, particularly in physics. For example, during the time of Lorentz and Einstein, symmetries were mostly considered mathematical curiosities that were highly valuable to crystallographers, but not considered fundamental laws of nature [49] or one fundamental concept in physics is the principle of symmetry, which postulates that nature's laws maintain their invariance under certain transformations [50].

Previous research conducted worldwide has indicated that PETs often have limited skills when it comes to symmetry and rotation, which helps them produce inaccurate drawings that do not fulfill the desired level of knowledge. Ignoring these challenges during the teacher training period will result in incomplete education during the teaching course.

Law [51] conducted a study on the ability of PETs to perform geometric transformations, exploring how they learn and process their knowledge. During a geometry course, 18 prospective teachers were asked to define and provide examples of geometric transformations. The researcher observed that these individuals struggled to define transformations accurately, using objective or abstract terms. Similarly, in a recent study [52], prospective teachers struggled to identify the center of rotation when asked to describe a figure's rotation around a point. It has also been reported that elementary students encounter difficulty in identifying rotation centers [14, 53]. Sometimes, these prospective teachers noted that they rotated figures at specific angles, even though these angles were limited to 90, 180, 270, and 360 degrees. Other studies confirm that while reflection symmetry is more straightforward, rotational symmetry is challenging [54-56]. Furthermore, according to the literature [57], students encounter challenges in understanding rotation angles.

It was observed that only 44.4% of teachers could accurately rotate an object and find its center of rotation [58]. This was due to the difficulties they faced with the concept of the center of rotation. Hence, to accurately define

the concepts of translation, reflection, and rotation during teacher training and address the associated challenges, researchers [52] suggest that it is very important to involve more students in undergraduate courses related to mathematics education. About the studies conducted on van Hiele's levels of geometric thinking, the main results of the study on pre-service teachers at E. P. College of Education in Bimbilla, Ghana, were that a large proportion of the pre-service teachers demonstrated lower-level geometric thinking abilities. Specifically, many of the participants showed some levels of geometric thinking at the first and second van Hiele levels, which involve recognition and visualization of basic geometric shapes and their properties. Relatively few participants reached levels three, four, and five, which involve using deductive reasoning to make connections between geometric concepts and develop a more sophisticated understanding. The study identified a need for improvements in pre-service math teacher education programs in Ghana to better prepare teachers for teaching geometry and promoting higher-level geometric thinking among students [59]. The summary of research articles in this field indicates that they explore the van Hiele model of geometric thinking and its potential to improve mathematics education. The results of these studies are significant and can be summarized as follows:

Firstly, the papers provide a clear and concise explanation of the five levels of geometric thinking in the van Hiele model. This understanding can help educators assess and teach their students better. Secondly, the importance of recognizing a students' current level of geometric thinking before introducing new concepts is emphasized in these papers. By doing so, educators can tailor their teaching methods to suit the students' needs, resulting in more effective learning. Thirdly, the papers also provide real-world examples of how geometric thinking can be applied in fields such as architecture and engineering, making learning more practical and motivating for students. Finally, the potential for interdisciplinary learning is highlighted in these papers, indicating how the van Hiele model can be integrated into various subjects leading to a well-rounded education for students. Furthermore, these studies paper highlight the significance of the van Hiele model of geometric thinking in mathematics education and offer valuable insights into how educators can use this model to enhance student learning.

On the other hand, the study conducted by Reyhani et al. [15] indicates that the participants demonstrated competence in van Hiele's third level of informal inference. However, they fell short of reaching the fourth level of formal inference. It is evident from these results that the participant's proficiency falls below the expectations set for mathematics teachers and students at the fourth level. This suggests that the current geometry lessons in the undergraduate program of mathematics education may not adequately equip students with the knowledge required to teach high school geometry effectively.

Nowadays, numerous studies have been conducted using cognitive science methods. For example, research entitled 'The Role of Symmetry in the Aesthetics of Residential Building Façades Using Cognitive Science Methods' [19] utilized eye movement recording tools to demonstrate that symmetric patterns attract more attention than asymmetric patterns [approximately 72% of participants chose structures with symmetry lines as aesthetically pleasing]. Additionally, in the displayed images of symmetrical facades (with horizontal and vertical axes), the participants' attention was more focused on the axis of

symmetry than other points. Similarly, in this research, it was aimed to evaluate PETs responses in selecting various symmetric images at the Analysis level of the Van Hiele model using cognitive science methodology.

Method

Participants

The participants in this research consisted of 50 female PETs at Fatemeh Al-Zahra campus of Farhangian University in Isfahan and 21 male and female PMETs at Shahid Rajaee Teacher Training University in Tehran.

The PETs of Farhangian University of Isfahan were divided into two groups: 42 students who had not learned the concept of geometric transformations in their undergraduate program (NPGT), and 8 students who had learned this concept in their undergraduate program (PGT).

Instruments

The measurement tool used in this study consisted of two tests, which were developed by the researchers. The details of each test are explained below:

Test questions of PETs

The first question involved identifying three symmetrical figures among five figures, representing Van Hiele's first level. The second question involved evaluating the correctness of four statements related to the concepts and characteristics of rotation, center, and axis of symmetry, which represent the second level of Van Hiele (Fig. 4). The correct answers for the test were determined based on the following criteria: 1) choose three symmetrical figures [B, D, and E] from the given five figures for the first question, and 2) determine the correct valuation of at least three of the four propositions raised for the second question.

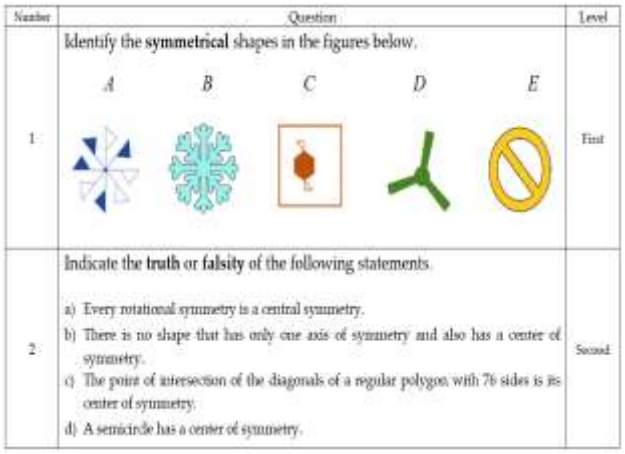


Fig. 4: Test questions based on van Hiele's theory.

The evaluation of the PTs group achievement at Van Hiele levels was qualitative based on the grading system proposed by [60]. Fig. 5 illustrates both qualitative and quantitative scales used to measure the process of achieving a level. This section can be divided into subheadings to provide a clear and organized description of the experimental results, their interpretation, and the conclusions drawn from the study. The section should be concise and precise, allowing readers to understand research outcomes clearly.

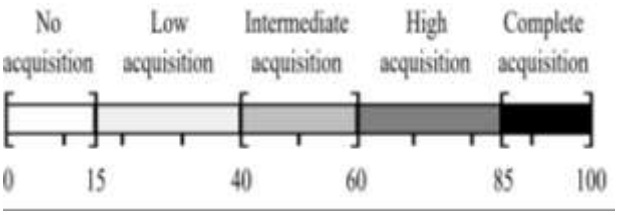


Fig. 5: Degrees of acquisition of a van Hiele level defined by [60, 61].

Test question of PMETs

To assess the cognitive perception of symmetric images, a test consisting of 5 symmetric images at Van Hiele level 2 (Analysis) was designed and administered to PMETs.

Stimuli used in the PMETs test

The images selected for this cognitive test were categorized into two groups: the first category is called Monosymmetric and includes images

with a single type of symmetry, while the second category is called polysymmetric and includes images with two types of symmetry. In Fig. 6, Monosymmetric images are those with only one type of rotational (a), central (b), or axial (c) symmetry, while polysymmetric images include shapes with two types of axial-rotational (d) or axial-central (e) symmetry. Symmetries with 360-degree rotation (such as those naturally present in all 5 images) were disregarded.

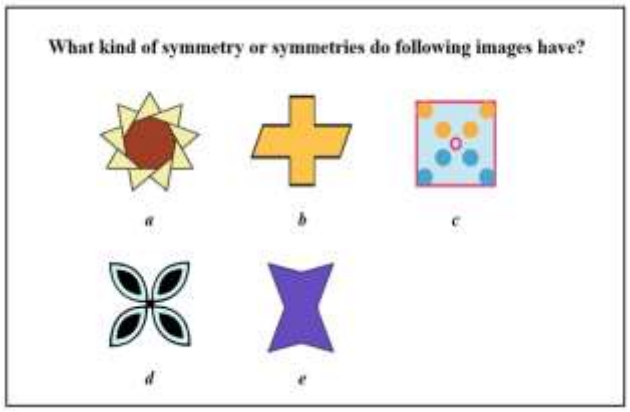


Fig. 6: The test question is based on the second level of Van Hiele's theory.

Procedure

The mixed quantitative-qualitative survey method was utilized to collect the data for this study. The measurement tool comprised two tests designed based on the Van Hiele theory and adapted from the levels of Van Hiele as presented by Soon [35]. The reliability of the test was assessed through Cronbach's alpha coefficient, which was found to be 0.68. The validity of the test was verified by mathematics professors.

The Eye Tracker device and cognitive science methods were employed to identify the type of symmetry in the designed images at the second level of the Van Hiele theory.

Procedure used in the PMETs test

Each trial began with a white fixation cross (+) on a gray background at the center of the screen (17'' CRT; refresh rate, 75 Hz; screen resolution 1920×1080; viewing distance 75 cm) for 500 milliseconds (ms). Then, questions and options were displayed for 500ms each. Finally, a symmetrical stimulus was shown. Participants viewed the stimulus and selected their answer from three options (rotational, central, and axial symmetry) with a mouse click on that option. Their eye movements were recorded throughout the task. One block of trials was collected from each participant, containing five trials of all symmetrical stimuli as shown in Fig. 6 (each presented once). Each block took 10 to 15 minutes to complete. See Figure 7 for a diagram of the paradigm. The task was implemented using the Psychophysics toolbox of MATLAB b2016 software [62, 63].

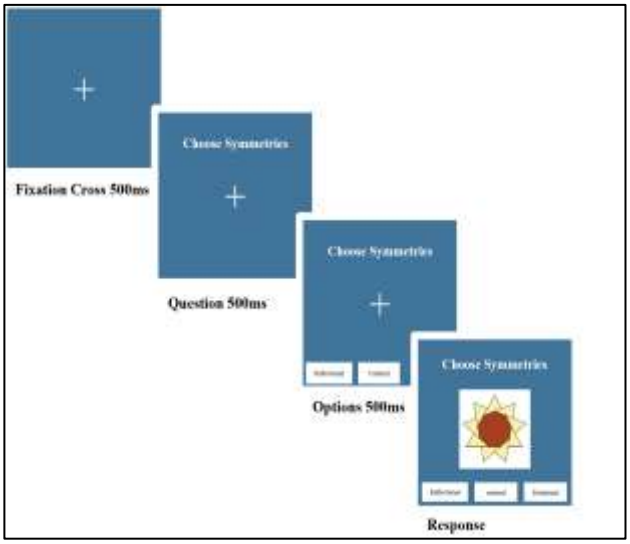


Fig. 7: Details of the test implementation in the computer laboratory of Shahid Rajaee Teacher Training University.

Eye Monitoring

Researchers used a non-invasive infrared eye-tracking device called Eyelink 1000 to monitor the participants' left-eye gaze positions during the study. The system measured the reflection of the pupil and cornea, with an accuracy of 0.25-0.75 visual degree. The researchers tracked the participants' eye movements to ensure that they were focused on the stimuli and to obtain their eye position.

Results and Findings

In this part, the research questions will be answered according to the analysis of the obtained data and the separation of the sample groups.

Results of PETs

The analysis of the data collected from the responses of PETs belonging to the PGT and NPGT groups to answer the first research question is presented in Table 3. In response to the second research question, the results of assignments conducted based on the questions and the first two levels of the van Hiele will be presented and analyzed.

Table 3: The percentage of correct answers to the questions and the level of qualitative achievement of van Hiele levels.

Sample	Question number	Frequency	Percent%	Qualitative acquisition of van Hiele levels
NPGT	1	11	26.19	Low acquisition
	2	6	14.28	No acquisition
PGT	1	6	75	High acquisition
	2	3	37.5	Low acquisition
Total	1	17	34	Low acquisition
	2	9	18	No acquisition

It can be concluded that PETs have the minimum necessary characteristics to achieve the first level of the Van Hiele theory, but they have not obtained the minimum characteristics necessary to achieve the second level of the Van Hiele theory. The details of this claim are shown in Table 3 and in summary, Fig. 8 illustrates the respondents' success rate percentage in answering the test questions.

The first question of the test and level one of van Hiele

The NPGT participants demonstrated a performance rate of 26.19%, falling in the low range of the first level of van Hiele, whereas the PGT participants scored 75%, falling in the medium range of the first level, see Table 4. All participants demonstrated success in identifying asymmetric Figs (A and C). In regards to the recognition of rotationally symmetric figures, all participants identified the snowflake (B) as rotationally symmetric but had a lower level of success in identifying the other two symmetrical figures. The causes of this difference resulted in the emergence of the idea of investigating geometric thinking based on cognitive science methods and designing and implementing the second test.

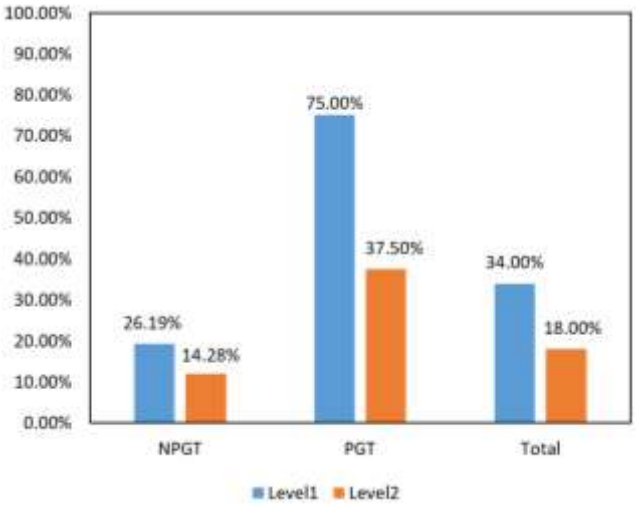


Fig. 8: The percentage of correct answers to van Hiele levels.

The second question of the test and the level of van Hiele

The Table 5 illustrates that the NPGT students were unable to reach the second level, with a performance rate of approximately 14%. Conversely, PGT students showed some improvement, scoring 37.5% in gaining a low level of the second van Hiele level theory. Interestingly, most of the errors made by the students were in response to questions related to the relationships between the line of symmetry and center of symmetry and relationships between rotational and central

symmetry, affirming the significance of the research topic.

Results of PMETs

In the analysis of the data recorded by the Eye Tracker device (Eye Link100), the criteria listed in

Table 6 is taken into consideration for detecting the type of symmetry in the images displayed on the computer. The received response's scan path and heat maps were compared and analyzed with respect to the three groups considered.

Based on the successful performance of PETs in recognizing snowflake image as symmetrical figure, the researcher hypothesized that PMETs as an expert group would also excel in recognizing the rotational symmetry of Figs 6a or 6b. Therefore, the decision was made to conduct the cognitive science test, and its results demonstrated that this hypothesis was incorrect.

Fig. 9, which is an example of a scan path of completely correct and completely incorrect answers of students, according to the number of recorded saccades and the direction of eye movement in each image, shows that there is a significant difference between the two groups of answers so the scan path results confirm one of the research questions. This distinction is also evident in their response percentages (see Table 7).

Table 4: Percentage and frequency of correct identification of symmetrical and asymmetrical figures.

Sample		Figure number					based on the set criteria
		A	*B*	*C*	*D*	*E*	
NPGT	Frequency	42	42	42	10	19	11
	Percent%	100	100	100	23.80	45.23	26.9
PGT	Frequency	8	8	8	7	7	6
	Percent%	100	100	100	87.5	87.5	75
Total	Frequency	50	50	50	17	26	17
	Percent%	100	100	100	34	52	34

Table 5: Frequency and percentage of correct valuation of the second question.

Sample		Correct evaluation of the proposition				based on the set criteria
		A	*B*	*C*	*D*	
NPGT	Frequency	16	8	37	23	6
	Percent%	38.08	19.0	88.09	54.76	14.28
PGT	Frequency	3	7	3	3	3
	Percent%	37.50	87.50	37.50	37.50	37.50
Total	Frequency	19	15	40	26	9
	Percent%	38	30	80	52	18

Table 6: Criteria considered for response analysis.

Images	Completely Correct	Roughly correct	Ctelompley Incorrect
Monosymmetric	One correct choice without incorrect choice	The first choice is correct or incorrect and the second choice is incorrect or correct	Zero correct selection
Polysymmetric	Two correct choices without incorrect choices	Two or one correct choice	Zero correct selection

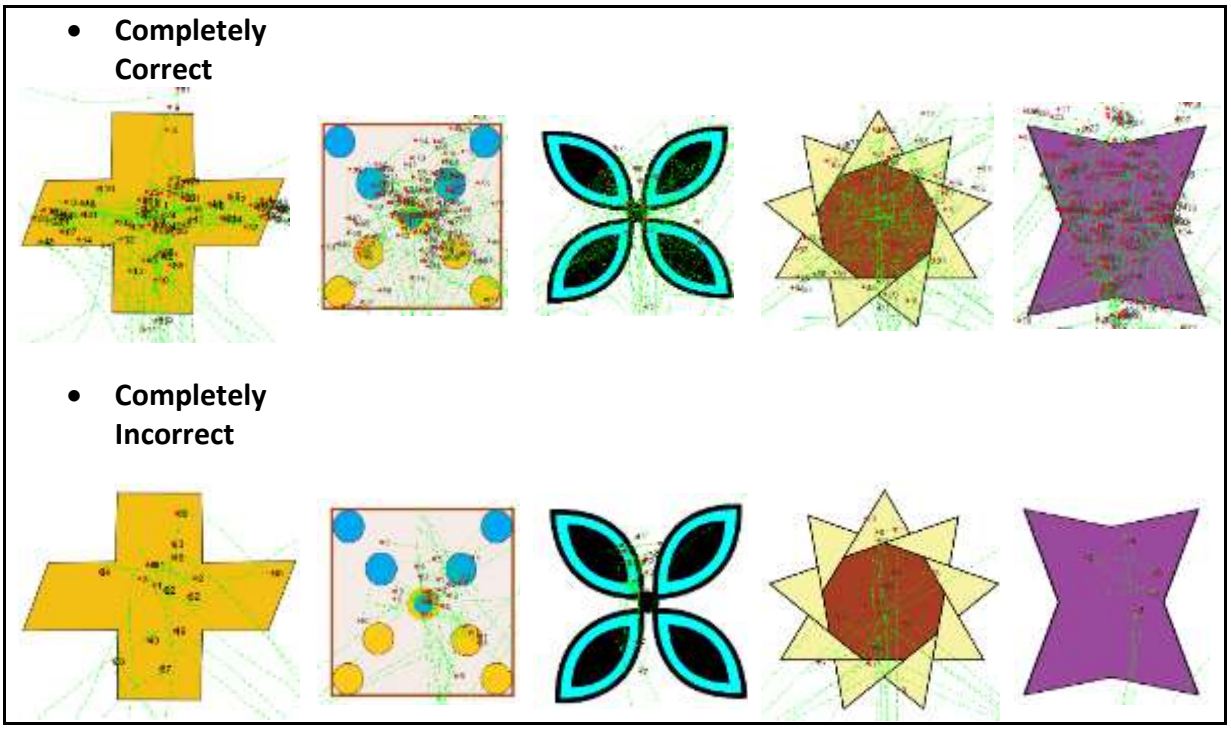


Fig. 9: Number of saccades and fixations in the scan path.

Table 7: Choosing the symmetry of the images according to the considered criteria.

Image	Symmetry type	subject	Correct %	Roughly correct %	Incorrect %
	Rotational	Female	50	50	0
		Male	26.66	46.66	26.66
		Total	33.33	47.61	19.04
	Central	Female	50	3.33	16.66
		Male	53.33	26.66	20
		Total	52.38	28.57	19.04
	Axial	Female	50	33.33	16.66
		Male	100	0	6.66
		Total	80.95	9.52	9.52
	Rotational Axial	Female	16.66	83.33	0
		Male	6.66	86.66	6.66
		Total	9.52	85.71	4.7
	Central Axial	Female	16.66	66.66	0
		Male	6.	20	6.66
		Total	47.61	47.11	4.7

Moreover, the scan path and heat map images reveal that certain participants' inability to provide accurate responses can be attributed to factors such as inattentiveness, inadequate attention to detail, and incomplete observation of the images. On the other hand, the outcomes derived from participants' heat map images validate the findings of previous research [64], indicating that reflections with vertical or horizontal mirror lines are generally more

accessible for students to visualize compared to reflections with diagonal mirror lines.

The counts and percentages of selected symmetry types for each image in Table 8 reveal that, across all images, PMETs with an accuracy exceeding 60% were capable of correctly identifying image symmetries. However, their accuracy diminished in their final responses. In certain cases, their second or third choices were made incorrectly, resulting in inaccurate answers to the questions.

The difference in choosing the central symmetry option between image b (monosymmetric) and image e (polysymmetric) is also evident, with percentages of 80.95% and 76.19%, respectively. Notably, the disparity in choosing rotational symmetry between monosymmetric and polysymmetric images is 5 times that observed for central symmetry. These variations are further validated by the heat map images. For instance, the correct answer image in heat map Figure 10a displays a higher number of saccades compared to Fig. 11d, affirming these discrepancies.

On the other hand, in the two polysymmetric images (d) and (e), the linear symmetry option has been chosen by the participants with close percentages of 80% and 85%, respectively. In contrast, the detection percentage of linear symmetry in the monosymmetric image (c) increased to approximately 95%.

The sum of these results, together with the results of the order of correctly recognizing the symmetry of the images (axial, central, central axial, rotational, and finally rotational axial), show that the students' skill in distinguishing the type of symmetry in monosymmetric images is better than in poly symmetric images.

Fig. 10-11 show heat map images of PMETs tests according to the order of selection of the options in the test. It should be noted that the range of colors from cool to warm tones shown in the following images indicates the least to most focal points emphasized. Below is a summary of the findings derived from these images.

Table 8: Choosing symmetry in each image.

Image	Sample	Axial		Central		Rotational	
		f	%	*f*	%	*f*	%
	Female	0	0	3	50	6	100
	Male	3	20	9	60	12	80
	Total	3	14.28	12	57.14	18	85.71
	Female	0	0	5	83.33	3	50
	Male	5	33.33	12	80	3	20
	Total	5	23.80	17	80.95	6	28.57
	Female	5	83.33	1	16.66	2	33.33
	Male	15	100	0	0	1	6.66
	Total	20	95.23	1	4.76	3	14.28
	Female	5	83.33	5	83.33	5	83.333
	Male	13	86.66	10	66.66	8	53.33
	Total	18	85.71	15	71.42	13	61.90
	Female	6	100	3	50	4	66.66
	Male	12	80	13	86.66	4	26.66
	Total	17	80.95	16	76.19	8	38.09

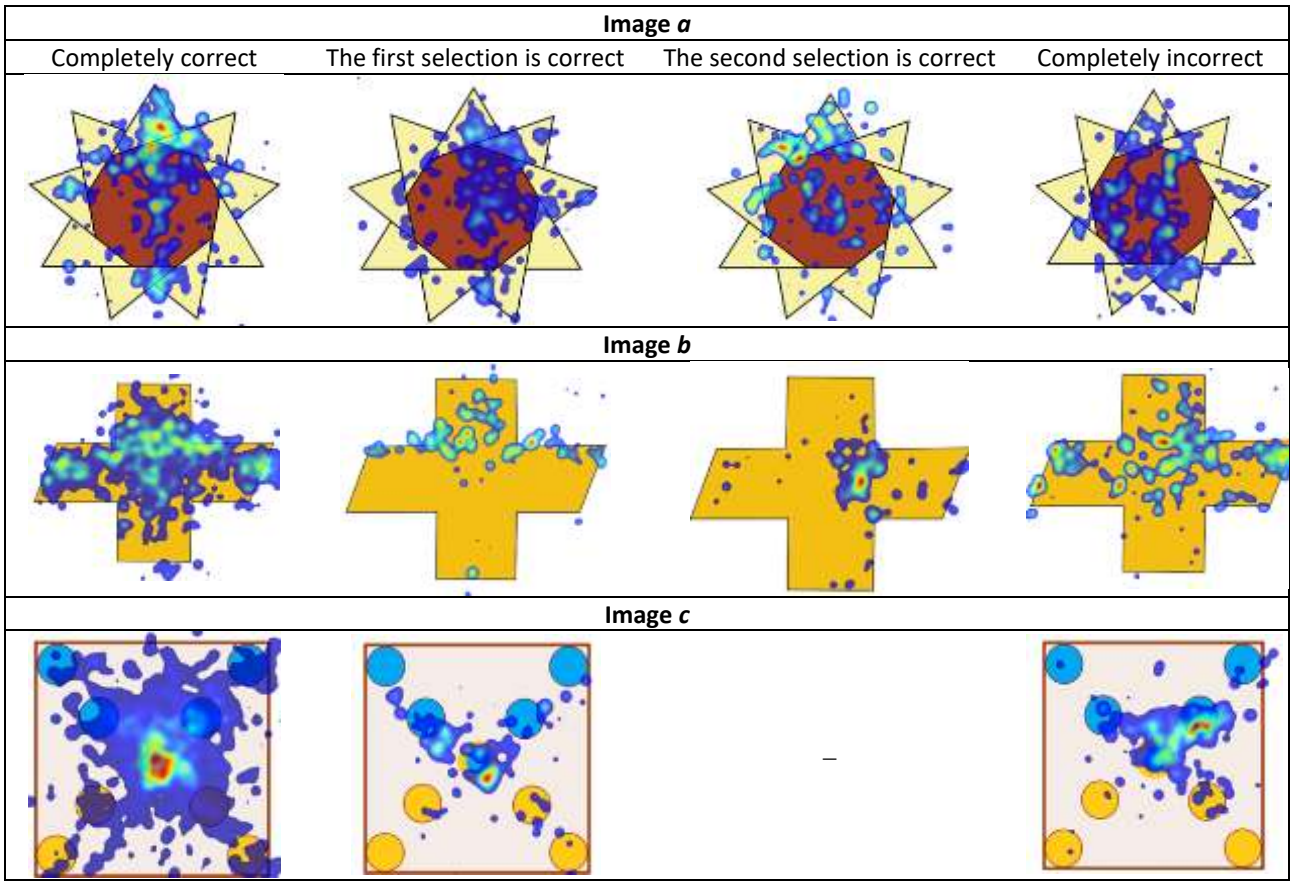


Fig. 10: Heat map monosymmetric images.

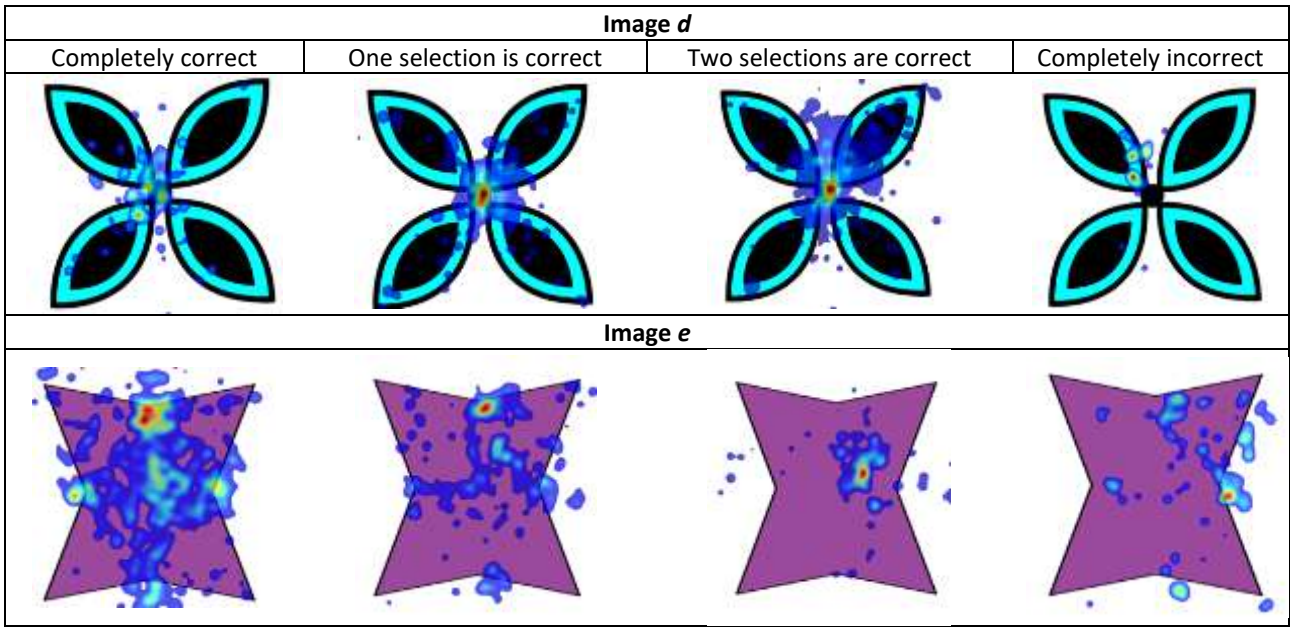


Fig. 11: Heat map polysymmetric images.

The results of these images follow a similar pattern to the scan path results. Images with 'completely correct' answers have more color points and warmer colors in the spectrum. In specific instances, the gaze trace and the warmer color spectrum indicate the determination of central or rotational symmetry, as well as the direction of rotation and the presence of axial symmetry (be it vertical, horizontal, or diagonal). The variable

number of saccades can indicate the level of accuracy and concentration, the complexity of the image, or the recognition and understanding of the participants in determining the type of symmetry of the test images.

It can be seen that the number of saccades in each of the categories 'completely correct' to 'completely incorrect' in Fig. 10-11 ranges from the highest to the lowest. Of course, there is an exception in this process. In Fig. 10a, in contrast to the other cases, the number of saccades in the heat map of the category 'completely incorrect' is increased. One of the reasons is the weakness of the students in the group PEMT in understanding the concept of rotational symmetry correctly and completely, which causes more difficulty in recognizing and ultimately increasing the number of saccades and fixations. The results of Table 7 confirm this weakness. Among the 3 monosymmetric images, the lowest percentage of success (33.33%) is related to the image (a). Also, in polysymmetric images, the image (d) which has rotational-axial symmetry has a much lower success rate than the image (e) with central-axial symmetry.

Based on the distribution of colored dots in the images below, the research literature is corroborated by the fact that students in this experiment exhibited a greater emphasis on identifying vertical and then horizontal lines, whereas they rarely distinguished the oblique symmetry lines. According to the responses of the participants to the test, the lowest percentage of completely correct responses is related to Fig. 10d (9.52%), which displays the fewest colored dots among all recorded images.

Discussion

According to the analysis of the data obtained in response to the research questions, the following conclusions can be drawn:

The response rate for PET group students was 34%, which represents a low degree of achievement from the first level of Van Hiele's theory. According to Gutiérrez et al. [60, 61] scaling, they failed to achieve the minimum degree of achievement of the second level.

The discrepancy in Van Hiele levels noted between the NPGT and PGT groups confirms the effectiveness of the educational curriculum centered on geometric concepts during the academic of PETs. This elevation in their geometric thinking level highlights the beneficial outcomes of the educational program on their cognitive growth in this domain.

In both PET and PMET groups, students can recognize symmetrical shapes correctly but have difficulty determining the type of symmetry of shapes, especially when they encounter polysymmetric shapes or oblique or rotational axial symmetry. The results of the cognitive test on the PMET group support this conclusion. It has been found that most students of both two groups do not correctly understand rotational and central symmetry, as well as their characteristics.

There is a significant difference between each image and each type of symmetry of the symmetrical shapes based on heat map images. Students of PMETs who exhibited greater attentiveness, as evident from their scan path images with higher numbers of saccades and fixations, demonstrated better performance in accurately identifying symmetry.

The analysis of the data in Table 8 demonstrates that PMETs with an accuracy exceeding 60% were generally effective in identifying image symmetries, although their accuracy slightly declined in their final responses. Notably, the selection of central symmetry differed significantly between monosymmetric (image b) and polysymmetric (image e) images, with percentages of 80.95%

and 76.19%, respectively. The disparity in recognizing rotational symmetry between these image types was even more pronounced, highlighting students' superior skill in identifying symmetry types in monosymmetric images, particularly linear symmetry (approximately 95% accuracy in image c). These findings emphasize the importance of further investigating students' proficiency in perceiving different symmetry types.

Comparing the performance of PEMT students in the 'Roughly correct' and ' Completely correct ' criteria reveals that they are more prone to errors when precise determination of symmetry type is necessary. This pattern was consistently observed in the results obtained from the PET group, which also exhibited subpar performance at the analysis level within the framework of Van Hiele's theory.

Notable differences emerged between the performances of males and females within the PEMTs. Specifically, girls exhibited greater proficiency in identifying rotational symmetry, whereas boys excelled in detecting central symmetry. Additionally, a significant contrast was observed in correctly identifying linear symmetry, with boys achieving a 100% accuracy rate compared to girls' 50% accuracy. These performance discrepancies underscore the presence of distinct patterns in geometric thinking between males and females.

Figs 10,11 present heat map images of the PMETs test. The color spectrum, ranging from cool to warm tones, signifies the emphasis from least to most focal points. The results from these images closely resemble the patterns observed in scan paths, where 'completely correct' responses exhibit warmer tones and more color points. These patterns often unmistakably indicate the determination of central or rotational symmetry, as well as the direction of rotation and the presence of axial symmetry (be it vertical, horizontal, or diagonal). The varying number of saccades serves as an indicator of accuracy, concentration, image complexity, or participants' recognition and understanding of the test image's symmetry type.

Conclusions

Geometric transformations as a part of geometry, which is one of the most challenging topics in school mathematics, was chosen as the subject of this research. The current research seeks to find the root of students' problems in learning this subject, hence the statistical population was selected from prospective teachers who are one of the primary and effective factors in the education of students. It is obvious that the educational topics in the teacher training course are important and have an impact on their teaching skills, and the results of the research confirm that the existence of the topic of geometric transformations in the current curriculum of prospective teachers is necessary, but not sufficient and needs to be revised. Also, the authors used cognitive methods to observe the roots of students' answers in the designed test.

The heat map analysis of PMETs test results revealed distinct patterns in symmetry recognition across different types of symmetrical shapes. Students exhibiting heightened attentiveness, reflected in increased saccades and fixations in their scan paths, demonstrated improved accuracy in identifying symmetrical patterns. Noteworthy differences were observed in selecting central and rotational symmetries, particularly in monosymmetric images, highlighting the importance of investigating students' proficiency in perceiving various symmetry types.

Overall, both groups of prospective teachers demonstrated a lack of success in comprehending and identifying various types of symmetry, particularly the non-expert group. It is advisable to implement essential revisions in the development of educational content and teaching methodologies employed by professors, aiming to enhance students' grasp of this subject. Moreover, leveraging technology such as augmented reality (AR), GeoGebra, and Cabri Geometry, along with online platforms like mathsisfun.com and brilliant.org, can significantly contribute to the improvement of cognitive and spatial abilities among both students and teachers in this domain. By incorporating these resources, educators can foster a more effective and engaging learning experience, ultimately yielding better outcomes in the understanding of geometric transformations and symmetry concepts.

There are potential factors that may contribute to the different patterns of geometric thinking observed, such as individual aptitude, previous experiences, or educational background. Moreover, it is imperative to promote an inclusive and equitable learning environment where all students, regardless of gender, have equal opportunities to excel in mathematics and related subjects. Further research on these factors or finding a stable mental map of thinking about geometric transformations can be future research topics.

Authors' Contribution

All authors have the same contribution.

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Conflicts of Interest

The authors have no conflicts of interest.

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AUTHOR[S] BIOSKETCHES

Modjtaba Ghorbani He is currently a professor of pure mathematics at SRTT University. His interests include Algebra and Mathematics Education.
Ghorbani, M. Professor, Department of Mathematics, Faculty of Science, Shahid Rajaee Teacher Training University, Tehran, I. R. Iran
mghorbani@sru.ac.ir

Fateme-Sadat Izadi She is an M. Sc student of mathematics education under the supervision of Modjtaba Ghorbani.
M. Sc student, Department of Mathematics, Faculty of Science, Shahid Rajaee Teacher Training University, Tehran, I. R. Iran
f.izadi@sru.ac.ir

Setareh-Sadat Roshan She is an M. Sc student of Artificial Intelligence under the supervision of Reza Ebrahimpour.

M. Sc student, Department of Artificial Intelligence, Faculty of Computer Engineering, Shahid Rajaee Teacher Training University, Tehran, I. R. Iran
setare.roshan1996@gmail.com

Reza Ebrahimpour He is currently a professor of Cognitive neuroscience at the Sharif University of Technology. His interests include Neuroscience, Artificial Intelligence, and Neuroeducation.

Ebrahimpour, R. Professor, Center for Cognitive Science, Institute for Convergence Science and Technology, Sharif University of Technology, Tehran, I. R. Iran
ebrahimpour@sharif.edu

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ORIGINAL RESEARCH PAPER

Metaverse Mastery: Unveiling the Magic of XR Technologies to Transform the Learning Experience of EFL University Students

E. A Salimi

Department of English Language and Literature, Faculty of Persian Literature and Foreign Languages, Allameh Tabataba'i University, Tehran, Iran

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* Corresponding author
easalimi@atu.ac.ir
(+98912) 3221916

ABSTRACT

Background and Objectives: The ever-changing and enigmatic future is taking form through a continuous wave of worldwide trends, advancements, and revolutionary ideas. Moreover, the rapid spread of the coronavirus and subsequent lockdown measures have accelerated the pace of technological advancements, significantly impacting multiple facets of our existence, employment, and connections. In the realm of learning, there has been an astounding and rapid transition from conventional classrooms to virtual platforms and groundbreaking advancements. Consequently, it becomes imperative for mankind to acknowledge and evaluate the profound influence of these developments, specifically within the domain of education. This innovative research project seeks to investigate the impressive capabilities of metaverse technology in addressing an unforeseen hurdle. Its main aim is to examine the deep influence of extended reality technologies on future education and assess if incorporating metaverse technology in learning will transform the higher education, generating notable progress and enhancing the quality of instruction.

Materials and Methods: The study aimed to comprehensively understand the research topic and its context by gaining insight into the participants' perspectives and experiences. To achieve this, a qualitative research was used with 63 purposefully selected participants. The participants included Iranian male and female EFL university professors, EFL university students, educational technology specialists, and futurists in science and technology. Data was collected by conducting focused-group discussions and episodic narrative interviews, as well as utilizing narrative inquiry methods on the Telegram network. Data collection continued until saturation was achieved, resulting in 25 participants for interviews and 38 individuals for narrative inquiry. To analyze the data and identify recurring themes, thematic analysis was conducted, involving initial coding, focused coding, and axial coding.

Findings: Findings revealed that metaverse technology plays a crucial role in the field of education and has a significant influence on higher education. Surprisingly, while analyzing the data, four main categories were identified, surpassing initial expectations. These categories include: 1) Empowering experiences: XR heightens sense of immersion, presence, and agency; 2) The immersive power of XR: Boosting enjoyment, interest, motivation, and self-efficacy; 3) Exploring boundaries of perception: XR triggers the illusion of body ownership and embodiment in virtual environments; and 4) The metamorphosis of the self: XR revolutionizes attitudes, behaviors, cognition, and physical body. Each of these categories represents the impacts of metaverse on future education. Understanding and embracing XR's impact on education is vital for educators, as harnessing the metaverse's potential benefits can greatly enhance teaching and learning experiences through more captivating and immersive environments.

Conclusions: The outcomes of this research carry significant implications for policymakers, educators, managers, leaders, practitioners, and all stakeholders involved in the field of education. They provide valuable insights into global trends, emerging technologies, innovations, and developments, and how they will likely shape the future of higher education. Given the rapid advancements in technology and the ongoing impact of the coronavirus pandemic, it is crucial to embrace these technologies and implement necessary changes in learning and teaching method to improve the quality of education. The hope is that this study will be a trusted source and offer guidance to future generations, helping them meet the evolving requirements of education.

NUMBER OF REFERENCES
66

NUMBER OF FIGURES
2

NUMBER OF TABLES
1

مقاله پژوهشی

فراشناخت دنیای مجازی: رمز گشایی قدرت فناوری های XR برای تحول تجربه یادگیری دانشجویان زبان انگلیسی

اسمعیل علی‌سلیمی

گروه زبان و ادبیات انگلیسی، دانشکده ادبیات فارسی و زبان های خارجی، دانشگاه علامه طباطبائی (ره) ، تهران، ایران

چکیده

پیشینه و اهداف: آینده‌ی ناپایدار و پیچیده‌ای که توسط روند های جهانی، فناوری‌ها و پیشرفت‌های تکنولوژیکی در حال شکل گیری است، درک عمیق انقلاب چهارم صنعتی و فناوری‌های آن را ضروری می کند. امروزه، همه گیری کوید ۱۹ نیز پیشرفت فناوری را به ویژه در حوزه‌ی آموزش تسریع کرده و بر بخش‌های مختلف زندگی بشر تأثیر گذاشته است به گونه ای که حوزه‌ی آموزش، به ویژه، یک تغییر سریع از یادگیری سنتی به سکوهای برخط را تجربه کرده است. این پژوهش به بررسی اثرات و پیامدهای فناوری متاورس، در مقابله با چالش‌های غیرمنتظره‌ی آینده می‌پردازد. هدف اصلی این مقاله بررسی این موضوع است که آیا فناوری‌های واقعیت گسترده، به عنوان یکی از اجزای سازنده ی زیست بوم متاورس، می توانند بر آموزش عالی آینده تأثیر بگذارند و آیا فناوری متاورس قادر است باعث ارتقاء کیفیت آموزش در آینده شود.

روش‌ها: تحقیق کیفی حاضربا هدف یافتن درک جامعی از موضوع تحقیق با بهره‌گیری از دیدگاه ها و تجربیات شرکت کنندگان صورت گرفت. برای دستیابی به این هدف، ۶۳ شرکت کننده‌ی ایرانی مرد و زن، شامل اساتید رشته زبان انگیسی، دانشجویان رشته‌ی زبان انگلیسی، متخصصان تکنولوژی‌های آموزشی و آینده پژوهان حوزه علم و فناوری به صورت هدفمند با روش گلوله برفی از سازمان ها و موسسات آموزشی مختلف در شهر تهران انتخاب شدند. داده ها ازطریق دو روش مصاحبه و روایت-پژوهی جمع آوری شد. جمع آوری داده‌ها تا دستیابی به اشباع ادامه یافت که منجر به انتخاب ۲۵ شرکت کننده برای مصاحبه‌ها و ۳۸ شرکت‌کننده برای روایت-پژوهی شد. به منظور تجزیه و تحلیل داده ها، محقق از روش تحلیل مضمون شامل کدگذاری باز، کد گذاری متمرکز و کد گذاری محوری استفاده کرد.

یافته‌ها: تجزیه و تحلیل یافته‌های تحقیق حاضر نشان داد که فناوری متاورس نقش بسیار مهمی در زمینه‌ی آموزش دارد. درنتیجه‌ی تجزیه وتحلیل داده‌ها چهاردسته مضمون اصلی شناسایی و استخراج شدند: ۱) تجارب توانمند: واقعیت توسعه یافته، حس غوطه ور شدن، حضور و عاملیت را افزایش می دهد، ۲) قدرت فراگیر: واقعیت توسعه یافته، باعث افزایش لذت، علاقه، انگیزه و خودکارآمدی می شود، ۳) کاوش در مرزهای ادراک: واقعیت توسعه یافته، توهم مالکیت بدن و تجسم را در محیط های مجازی ایجاد می کند، ۴) دگردیسی خود: واقعیت توسعه یافته، نگرش ها، رفتارها، شناخت و فیزیک افراد را متحول می‌کند. این دسته بندی‌ها به وضوح تأثیر فناوری واقعیت توسعه یافته را بر آموزش عالی آینده نشان می‌دهند. درک مزایای گنجلندن متاورس در آموزش، می‌تولند محیط‌های جذاب و فعال‌تری را در فضای آموزش عالی فراهم کند.

نتیجه‌گیری: نتایج این مطالعه کاربردهای مهمی برای سیاستگذاران، اساتید، مربیان، مدیران، رهبران، دانشجویان، دست اندرکاران و تمامی ذینفعان آموزش عالی دارد و باعث افزایش بینش در مورد روندهای جهانی، فناوری‌ها، فناوری‌های نوظهور، نوآوری‌ها و پیشرفت‌ها و چگونگی تاثیر آنها درشکل دهی آینده‌ی آموزش می شود. با توجه به پیشرفت های سریع در فناوری و به ویژه تأثیر بیماری کووید ۱۹ در آموزش، پذیرش این فناوری‌ها و ایجاد تغییرات لازم برای بهبود کیفیت آموزش بسیار مهم است. امید است که این تحقیق منبعی قلبل اعتماد و انگیزه ای برای مطالعات آتی در زمینه آموزش و تحول نظام آموزش عالی آینده کشورمان باشد.

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تجربه یادگیری
متاورس
تکنولوژی‌های XR

*نویسنده مسئول
easalimi@atu.ac.ir
(+98912) 3221916

Introduction

The world is experiencing a rapid and significant change called the Fourth Industrial Revolution (4th IR), which is characterized by its unique features, vast scope, and technological advancements. This revolution is profoundly transforming key aspects of human existence, including lifestyle, employment, and social interactions, at an astonishing pace and with a broad impact [1]. Schwab's proclamation of the 4th IR marks an unprecedented shift in human history that surpasses all previous revolutions [2]. The distinguishing feature of this revolution is the merging of physical, digital, and biological technologies, which include artificial intelligence (AI), robotics, the internet of things (IoT), biotechnology, and nanotechnology [3]. These technologies are pivotal in driving and accelerating the 4th IR, impacting diverse sectors including industry, agriculture, medicine, economics, and academia [4, 5].

The Fourth Industrial Revolution, according to the World Economic Forum [6], is shaping various aspects of our lives and affecting our identity, privacy, ownership, consumer behavior, work-life balance, professional growth, expertise acquisition, social responsibilities, and interpersonal connections. Therefore, to understand the 4th IR, we must acknowledge our physical, emotional, cognitive, and spiritual aspects, as asserted by Schwab [2]. This gains importance as talks about the possible rise of the Fifth IR have begun. The evidence indicates upcoming technological revolutions, bringing about diverse changes and challenges. Despite the uncertain future, it is clear that significant disruptions will alter various aspects of human life. Moreover, the global community has already experienced transformative shifts due to the unprecedented coronavirus pandemic [7]. Lockdowns during the health crisis have led to a significant increase in technology adoption, inducing widespread changes and diverse online activities across various domains in our society [8]. Nowadays, the use of technology in education is on the rise, reflecting a wider trend. Indeed, investing in the education sector to foster adaptability is necessary in a world demanding more IT expertise. However, underdeveloped nations face hurdles in their education systems, lacking vital skills. Notably, the current economy increasingly values skills, marking an important change in recent times [9].

Many facts indicate that the coronavirus pandemic and the emergence of Industry 4.0 have greatly affected education, leading to changes in policies, teaching techniques, and learning possibilities [10]. Reforming the education system and aiming for top-notch education has become crucial now. Hence, devising integrated and comprehensive strategies that meet the needs of the 4th IR is essential in order to nurture students who have a distinct blend of abilities, knowledge, and innovation, empowering them to make the most of the 4th IR. Without achieving this, there will be a halt in progress and lack of advancement. Ultimately, without a quality education that involves all stakeholders, including the public and private sectors, academia, and civil society, it is impracticable to effectively address this revolution. Lately, people in different fields, especially education, have been highly interested in metaverse technology. The metaverse is a digital ecosystem or structure created by the convergence of extended reality (XR) technologies, such as virtual reality (VR), mixed reality (MR), augmented reality (AR), and other technologies like artificial intelligence (AI), immersive digital space, and real-time communication. It has garnered global attention and become a topic of debate today.

Despite the challenges, the value of striving to integrate this technology is immeasurable. This study aimed to investigate the effects of XR technologies on education, with a focus on showcasing their potential and uniqueness as part of the metaverse structure. The objective was to exemplify how metaverse technology can improve education. Therefore, a fundamental question was raised: How will integrating metaverse technology in education impact the future, potentially catalyzing transformative changes and enhancing the quality of education in the current system?

This study examines the effects and significance of metaverse technology on education, highlighting four categories related to XR technologies. The aim is to showcase the potency of the metaverse in future education. It presents metaverse technology as a significant trend in the 4th IR, with distinct characteristics and vast possibilities for education in the future. The study reveals significant impacts and implications of metaverse, offering valuable perspectives for leaders, educators, policymakers, and all educational stakeholders. These findings broaden stakeholders' comprehension of the benefits that come from incorporating the metaverse in education, focusing on its ability to improve the quality of learning. This is especially crucial for education authorities in developed nations striving to deliver exceptional education. Additionally, the research underscores the metaverse technology's potential to facilitate decentralized education, aligning with the objective of attaining excellent educational benchmarks. This research aims to facilitate the integration of the metaverse into educational institutions, fostering advancement and innovation in education. It anticipates stimulating further exploration of technology integration and endeavors to serve as a reliable reference and supportive resource for future generations, addressing evolving educational requirements.

Review of the Related Literature

The metaverse is a virtual world with different digital spaces for entertainment, socializing, and learning. It serves as a network of computer-generated environments where users can fully engage in activities like work, play, and education [11]. Recent advances in technology inch us closer to achieving the metaverse, a concept introduced by Stephenson in his book thirty years ago [12]. XR technologies are fueling the metaverse's expansion, transforming how we engage with the digital realm and unlocking new possibilities [13]. As it is shown in Fig. 1, metaverse is a blueprint for enhancing comprehensive human development. The rapid development of Internet communication techniques and hardware platforms, decentralization, the combination of virtuality and reality, and high human-computer interaction are the conspicuous characteristics of the metaverse [14].

By incorporating virtual reality and augmented reality, the metaverse expands upon traditional internet and social media platforms [15]. The metaverse aims to use technologies like 5G, blockchain, AI, and 3D graphics to create an interactive virtual version of the real world. It allows exploration through XR platforms like Meta [16]. Extended reality (XR) technologies, such as virtual reality (VR), mixed reality (MR), augmented reality (AR), range from computer-generated environments to physical reality without virtual elements [17]. Elbamby et al. [18] stated that the key difference among VR, AR, and MR is the method of integrating computer-generated content into the real world, supporting the same argument.

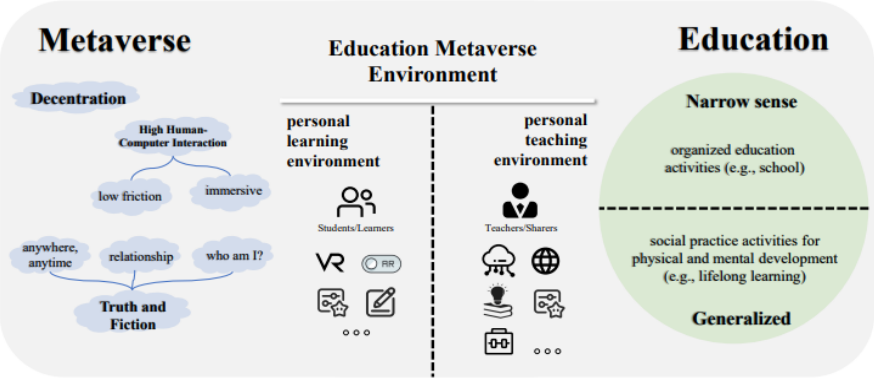

Fig. 1: The characteristics of metaverse and education
Source: Lin et. al, [14]

The study by Makransky and Lilleholt [19] found that 3D virtual learning environments, such as the metaverse, use VR, AR, and MR to recreate real-world settings for educational purposes. Makransky and Petersen [20] emphasize that AR, MR, and VR possess unique qualities such as immersion, interactivity, and invisibility, offering valuable benefits in education by creating sense of presence, control, and empowerment. Queiroz et al. [21] found that integrating XR learning environments leads to higher satisfaction and self-assurance among learners in their ability to acquire knowledge. Additionally, Kaplan-Rakowski and Gruber [22] suggested that language learners often struggle with complex texts, but immersive virtual reality has emerged as a motivating solution. Parong and Mayer's [23] research revealed that interactive virtual reality enhances learning by positively impacting emotions and cognition, improving learning outcomes. Furthermore, studies by Makransky and Klingenberg [24] and Makransky et al. [25] explored the emotional impact of immersive multimedia learning and revealed that highly immersive environments lead to increased presence and enjoyment. According to Wang et al. [26], XR's capabilities have the potential to enhance learning experiences by offering more realistic contexts compared to traditional classrooms.

Bailenson's [27] research showed that immersive virtual environments engage students and teachers effectively, which is challenging to replicate in real-life scenarios. Similarly, Makransky and Mayer [28] suggested that immersive virtual learning environments offer unique opportunities for experiential and situated learning that are typically not available in real-life situations. This is in line with the viewpoints of Di Natale et al. [29] who emphasized that immersive virtual learning systems offer authentic scenarios for engaging and contextualized learning, enhancing motivation and facilitating the transfer of knowledge. Numerous studies have indicated that the effectiveness of virtual learning experiences heavily depends on the technology utilized, which determines the level of immersion. For instance, the study conducted by Di Natale et al. [29] classified systems into three levels of immersion: non-immersive (desktop VR), semi-immersive (smart glasses or full dome), and fully immersive (head-mounted displays). According to Di Natale et al., [29], when using a head-mounted display (HMD) or a Cave Automatic Virtual Environment (CAVE), the perceived immersion in an environment is greater compared to a desktop virtual reality setup. Queiroz et al. [21] further explained that virtual reality systems track the user's head

movements and adjust the virtual environment accordingly, giving a 360° view of digital content. This creates an immersive experience using head-mounted devices, generating a computer-generated virtual space that appears realistic, as Kaplan-Rakowski and Gruber [22] described. A study by Wu et al. [30] revealed that HMDs in immersive environments are more beneficial than less immersive media, improving skill development, cognitive processes, and knowledge acquisition.

Makransky and Petersen [31] suggested that greater psychological presence in immersive environments enhances engagement and cognitive processing among students. This increased engagement requires more cognitive effort to comprehend learning materials. A study by Iriye and Ehrsson [32] suggested that individuals who feel a stronger connection to their virtual avatars have improved memory and self-awareness when recalling information. This indicates that incorporating multiple senses and our perception of our own bodies is essential in forming memories. Serino et al. [33] found that when participants experienced a congruent visuo-tactile condition, it led to a strong illusion of body ownership, self-location, and agency. This heightened their learning abilities, resulting in improved effectiveness and efficiency in the learning process. In an article, Schöne et al. [34] proposed that virtual reality has the potential to bring about changes in attitudes, brain function, and cognition by allowing individuals to embody different bodies. Liu [35] explores the 'Proteus Effect' introduced by Yee and Bailenson [36], which suggests that a person's behavior and attitudes in digital environments can be shaped by their virtual avatar. The appearance and actions of their digital representation can affect how they behave in both virtual and real-life settings.

Method

Participants

A group of 63 Iranian male and female, including English as foreign language (EFL) university professors, EFL university students, educational technology experts, and science and technology futurists, came together for an intriguing qualitative study. Out of the participants, 25 were selected to participate in two captivating interviews stages. The first stage involved a focused-group interview with 14 members, split into two sessions with four participant groups in each. The second stage involved conducting episodic narrative interviews with the remaining 11 participants. In addition, a total of 38 individuals participated in a narrative inquiry that was carried out using Telegram. Participants were recruited from various parts of Tehran, including research institutions, government organizations, technology companies, and universities. To ensure efficient engagement and effective data collection, a purposive and snowball sampling method was utilized. By involving experts and expanding the participant chain, data saturation was achieved, ensuring the study had an adequate sample size.

Instruments

This study aimed to explore the captivating world of the metaverse and understand its significant influence on the future of education. Two methods were employed to gather the data of the study. Firstly, interviews were conducted, which encompassed focused-group interviews and engaging episodic narrative interviews. Secondly, the narrative inquiry technique was employed to validate the data acquired from the interviews. The selection of the interview method was based on its convenience and usefulness in qualitative research. To collect diverse perspectives in a

structured setting, focused-group interviews were preferred, allowing for simultaneous discussions on the research topic. The episodic narrative interview was also effective in capturing personal stories and accounts, offering valuable insights into participants' actions and experiences. Narrative inquiry was particularly advantageous as it removed limitations such as time constraints and the requirement for face-to-face meetings. It encouraged participants to contemplate their experiences and share comprehensive insights through online networks, in real-time or at their own convenience. Different sets of questions were tailored for four groups of participants in both interviews and narrative inquiry to gather the required data. To ensure the content validity of questions, a team of experts diligently reviewed and approved them.

Procedure

In the first round of data collection procedure, interviews lasting 20 to 35 minutes, were recorded upon the participants' agreement. The conducted focused-group interview was split into two well-managed sessions, providing a non-threatening environment for participants to openly share their viewpoints and attitudes. The purpose, expected results, and advantages of participating in the interviews were clarified beforehand. The researcher then utilized probing questions to delve deeply into the areas of discussion, while carefully addressing any ambiguous remarks and seeking clarifications from the participants. The episodic narrative interview took place through various sessions, gathering comprehensive narrative accounts of participants' thoughts and experiences within specific episodes. In the second round of data collection, narrative inquiry established via Telegram group provided an environment for participants to engage in conversations. The inquiry focused on narrative affordances, including distributed authorship, digital recombination, and reviewability. Distributed authorship allowed for multiple voices to contribute to a narrative, resulting in a nuanced portrayal of different perspectives. Digital recombination involved taking elements from existing content and placing them in a new context to create fresh interpretations. Reviewability encouraged storytellers to critically examine their stories to ensure they aligned with societal norms and reality.

Data Analysis

The researcher used a three-step coding process to analyze the data, which included initial coding, focused coding, and axial coding. The interviews were recorded and transcribed for analysis. All voices in the Telegram group were first transcribed and then along with the texts written there were analyzed. The data underwent thorough examination multiple times, focusing on identifying important ideas and messages at various levels, such as words, phrases, sentences, and paragraphs, that were relevant to the interviews and research questions. In the initial coding phase, the aim was not to fully analyze the data but to highlight key points and relevant sections related to the research questions. These sections were coded and accompanied by explanations. In the focused coding stage, important themes were identified from the initial coded sentences and given appropriate codes. The codes were carefully examined to differentiate similar codes from distinct ones. This process resulted in the collection of numerous early codes and patterns with different themes, which were then organized into primary categories. Analyzing the patterns within individual codes played a crucial role in forming the main thematic categories, thus leading to the axial coding stage of the data mining process.

Results and Findings

The study found that metaverse is a crucial technology that is having a significant impacts and implications on future education. As it is shown in Table 1, the analysis of the data resulted in the identification of four main categories related to XR technologies, demonstrating the opportunities of the metaverse in future education, each of which discussed below in details.

Theme 1: Empowering Experiences: XR Heighten Sense of Immersion, Presence, and Agency

Participants agreed that immersive virtual learning environments are highly beneficial for both educators and learners. As per an EFL university professor, these settings offer immersive experiences, encourage experiential and contextual learning, and provide interactive, genuine, and realistic opportunities. According to him, the degree of immersion depends on the resemblance of visual, auditory, and haptic cues to the physical world. He conveyed his thoughts in the following manner:

The degree of engagement in virtual environments relies on elements such as precise tracking, high-quality visuals and audio, wide field of vision, and frequent updates. The level of user immersion or awareness of the virtual realm greatly influences the quality of their encounter.

He emphasized that the degree of total submersion sets apart a multifaceted cybernetic realm, observed on a computer screen and controlled with a mere mouse, from an extraordinary realm encountered through an awe-inspiring HDM or the mesmerizing CAVE, where the user is enveloped by large screens and views the environment with the aid of 3D glasses. In his perspective, an online learning environment with diverse elements may lack complete immersion, whereas the 'Cave' provides a partial immersive experience. On the other hand, the HDM takes immersion to another level by engulfing the user's entire field of view with the wonders of the virtual realm. He elaborated on his explanation as follows:

Table 1: Metaverse impacts and implications on future education

Technology	Findings			
	Theme 1	Theme 2	Theme 3	Theme 4
Metaverse Impacts and Implications on Future Education	Empowering Experiences: XR Heightens Sense of Immersion, Presence, and Agency.	The Immersive Power of XR: Boosting Enjoyment, Interest, Motivation, and Self-Efficacy.	Exploring Boundaries of Perception: XR Triggers the Illusion of Body Ownership and Embodiment in Virtual Environments.	The Metamorphosis of the Self: XR Revolutionizes Attitudes, Behaviors, Cognition, and Physical Body.

The system classification's levels of immersion range from captivating to mesmerizing. Let's compare the immersive 'Cave' system, which showcases your actual body, to the HMD that ingeniously generates a virtual body. It allows you to seamlessly explore a virtual universe while observing your digital self, completely engulfing you in a vivid digital reality.

A futurist remarked that true immersion can be achieved by capturing real-life sensations, encompass a multitude of senses, and present an extensive range of representations, resulting in a magnificent experience. From this perspective, utilizing a HMD for education is superior to watching a 2D video because the HMD's immersive capabilities provide a captivating learning experience. He thought HMDs can revolutionize education by comparing immersive VR to desktop VR for proficiency development. He presented evidence supporting the effectiveness of instructional and scaffolding approaches in highly immersive settings, and elucidated how the combination of immersive experiences with effective teaching methods and scaffolding techniques produces valuable advantages. He summarized his thoughts in the following manner:

Effective instructional design and immersive virtual environments stimulate learners' cognitive processes in learners by encouraging information selection, organization, and integration, ultimately enhancing the overall learning process.

As per an expert in educational technology, learning in immersive environments has numerous benefits, such as a stronger sense of being present and agency. He highlighted the psychological differences between non-immersive, semi-immersive, and fully immersive systems, emphasizing that the level of immersion directly impacts learner's agency and feeling of presence. The more immersive the experience, the more intense the sense of presence becomes. His opinion was articulated as follows:

The incorporation of presence and agency in immersive learning can greatly enhance students' learning. Presence induces a feeling of being in a virtual world, facilitating engagement and cognitive processing.

According to him, in a mesmerizing turn of events, as engagement spikes, students immerse themselves in the depths of their minds, investing a hefty amount of mental power in understanding. This grand display of mental exertion paves the way for a profound grasp of educational material, leaving an indelible mark on their memories, forever enhancing their cognitive prowess.

Theme 2: The Immersive Power of XR: Boosting Enjoyment, Interest, Motivation, and Self-Efficiency

In an awe-inspiring discussion on language skills, participants fervently accentuated the vital role of enthusiasm and joy in nurturing linguistic advancement. Emphasizing captivating teaching methods, they underscored the significance of comprehending how XR affect student emotions and achievements. As per a futurist, incorporating immersive XR tech in education can enhance language acquisition by increasing student engagement, motivation, and confidence. Here's a mesmerizing illustration of how the futurist articulated his concept:

Magical XR advancements enchant and mesmerize students, kindling an insatiable thirst for knowledge. Through immersive and interactive educational encounters, students embark on a captivating journey of discovery, fostering profound comprehension, boundless enthusiasm, and relentless motivation.

According to the futurist, by employing video cameras and HMD, one can forge an enchanting virtual realm where learning excels. This realm encompasses 3D items, avatars, and scenarios that amplify the learning process through imbuing a feeling of possessing a body, grasping spatial concepts, and effortlessly engaging with the virtual domain.

An EFL university student opined that XR technologies provide a superior and delightful educational encounter compared to real-world scenarios. He expressed that XR's virtual learning platforms offer a protected haven for skill development, self-assurance, and cultivating a positive self-image. As per the student, VR learning environments serve as a secure avenue to tackle challenging topics. Moreover, XR technologies stimulates problem-solving abilities by immersing students in realistic virtual settings, enhancing commitment, eagerness, and esteem, bolstering academic success in various disciplines. Here's an example of how the participant expressed his opinion with eloquence:

In virtual environments, students often experience complete absorption and presence by participating in game-like activities, enjoying involvement, and interacting with peers and instructors.

According to the student, virtual environments in XR tech enhance language learning by creating realistic experiences, promoting natural language usage, and effective outcomes. He claimed that immersive virtual experiences provide learners with an exciting opportunity to enhance their language abilities. This cultivates a favorable approach to learning, resulting in heightened enthusiasm, attentiveness, and dedication. Educators can foster self-confidence in students, enabling a supportive atmosphere for continued academic involvement, he stated.

Immersive technologies have also been acclaimed by an educational tech expert for their captivating, interactive, and empowering attributes. A remarkable illustration of this groundbreaking innovation is the captivating domain of advanced virtual reality. This is the magnificent manner in which he expressed his ideas:

The headset is an essential instrument that allows users to completely immerse themselves in the virtual realm, utilizing head tracking technology to perceive and engage with a 360-degree virtual environment for an incredibly lifelike experience.

The educational technology specialist compared lessons in immersive systems like HMD's to those in less immersive systems like desktop VR or video. This showcased the significant influence fully immersive systems have on learners' attraction, motivation, and confidence. One of the fascinating statements uttered by the renowned specialist went as such:

By engulfing students and teachers in immersive environments, high-immersion systems can enhance their self-belief and learning outcomes. These systems eliminate distractions, stimulate multiple senses, and offer versatile representations.

The specialist recommended using HMD to deliver lessons because it enhances engagement and captivates students better than regular 2D videos. By providing more immersive experiences, such technology aims to offer realistic learning opportunities that boost student motivation and ultimately increase their confidence in their abilities.

Theme 3: Exploring Boundaries of Perception: XR Triggers the Illusion of Body Ownership and Embodiment in Virtual Environments

The captivating discussion among participants highlighted how XR's outstanding capability to foster a profound sense of bodily ownership and virtual embodiment, makes it an invaluable tool for improving learning, problem-solving, and critical thinking in in various disciplines. A futurist highlighted that by leveraging the potential of the human intellect and XR advancements, educators and learners can gain remarkable control over their virtual avatars within educational settings. He expressed his idea in the following manner:

> *IVR technology provides an effortless means of transferring the illusion of body ownership to non-body objects or radically different bodies. This allows for a highly adaptable representation of the body that can be molded and transformed in unique ways.*

An EFL university student eloquently elucidated the rubber hand illusion (RHI) experiment as a conduit for unraveling the visionary convictions of the futurist [37]. With utmost finesse, he vividly depicted a remarkable experiment that flawlessly demonstrates how the brain can be tricked into believing an outside object is part of the body, illuminating the mesmerizing mechanics of the rubber hand illusion. one of the quotes he made was phrased like this:

> *The rubber hand illusion experiment manipulates our senses by stroking a fake hand and a real one together, creating confusion. This synchronized stimulation deceives the brain into accepting the fake hand as part of the person's body.*

The university student observed that in rubber hand illusion experiment the brain merges synchronous yet separate inputs to form a unified experience. He stated that if visual and tactile stimulation were not in sync or happened at different times, the illusion would either not happen or would be weaker. Essentially, for the brain to perceive the fake hand as part of the participant's body, the visual and tactile inputs must be coordinated and synchronized, he conveyed.

An EFL university professor put forward the idea that when English language teachers and students are aware that an object does not belong to their body, they can still develop a deep sense of possessiveness towards it. His opinion was that by utilizing multisensory techniques, it would be possible to create illusions of being outside of one's own body. This was the manner in which he conveyed his viewpoint:

> *English language teachers and students can feel an unusual sensation of being close to or drawn towards a manikin's body by using it as a representation of a distant body in virtual environments, through synchronous stimulation.*

According to him, the integration of visual and tactile input can give the impression of being located behind one's own body, enabling

a rear view of oneself. In other words, equipping educators and learners with video cameras and HMDs makes it possible to fully possess a body. Synchronizing the touch and sight of a manikin body generates a subjective feeling of ownership, enhancing involvement and immersion in XR learning, he mentioned.

Theme 4: The Metamorphosis of the Self: XR Leads to Alterations in Attitudes, Behaviors, Cognition, and Physical Body

Participants embarked on an exciting journey into XR technologies, motivated by their vast potential to transform education. They strongly believed in the power of these innovations to fundamentally change how knowledge is acquired, altering learners' cognition and behaviors. Notably, an educational technology expert proclaimed that adopting VR avatars can catalyze transformative shifts, impacting conduct online and in cyberspace. She fortified her reasoning by eloquently portraying her idea as follows:

> *In the virtual realm, individuals with attractive avatars are inclined to connect closely, while those with taller avatars exhibit greater assertiveness in negotiations than individuals with shorter avatars.*

A remarkable demonstration of the profound impact of physical changes on a student's self-image and mindset was provided by a brilliant EFL professor, who ingeniously crafted a hypothetical situation to illustrate her concept. His articulate description of the concept was as follows*:*

> *In a scenario where non-native students learn from virtual representations of a native English teacher and a non-native English teacher via a HMD, they display a stronger inclination towards the native teacher after observing their reflections for slightly over a minute.*

The professor explained how stereotypes affect people's perceptions of virtual bodies, citing biases against non-native English-speaking teachers. He also showed how social norms in virtual environments shape individuals' behaviors in reality. He expanded upon his explanations by presenting them in greater detail:

> *Virtual embodiment promotes empathy, understanding, and positive interactions in real-life, especially in interpersonal communication settings, through adopting diverse identities.*

One of the futurists discussed 'cortical body matrix' and its importance in maintaining body's spatial representation through multiple senses. The futurist stressed that the matrix is vital for our self-awareness and shapes our perception of and interaction with the outside world. He made a statement that went something like this:

> *The 'cortical body matrix' hierarchy suggests that claiming ownership of the whole body creates a sense of owning specific body parts, ensuring consistency in self-representation*.

According to the futurist, embodying a virtual avatar can lead to our brains integrating sensory information from the virtual world similar to the physical world, resulting in a strong sense of presence and ownership over the virtual body, even though we are aware it is not real. This can create a genuine feeling of

occupying the virtual form, he conveyed. The futurist elaborated his discussion as follows:

> *Modifying the virtual body can alter our core beliefs, showing a shift in our ownership of it. This solidifies how virtual embodiment* affects *our mindset and behavior.*

An expert in educational technology found that changing our sense of owning a body can significantly impact our thinking and emotions. He suggested using virtual embodiment to enhance mental health and questioned self-perception theories and stereotypes. The expert emphasized how our brain collaborates different regions to perceive the world using various senses, such as proprioception and vestibular, not just visual or auditory. These regions are crucial for directing actions and decision-making based on sensory input, he conveyed. He communicated his concept in the following manner.

> *The use of multisensory perception framework allows us to understand how our brains process sensory information from virtual environments, affecting cognition and behavior through changes in virtual body ownership.*

In conclusion, an EFL university student highlighted the potential implications of XR technologies in creating illusions of body ownership and virtual embodiment within educational settings. He suggested that further research is necessary to fully understand the cognitive and emotional effects of such experiences in teaching, as well as their potential impact on learning outcomes. One of the sayings attributed to him was stated as follows:

> *Several investigations have explored the effects of body ownership illusions on physical changes, including shifts in voice pitch and alterations in speech patterns, among participants exposed to virtual reality settings*.

He reported that the observed changes were only apparent in the synchronous condition, where the virtual body's movements were synchronized with those of the real body.

Discussion

Empowering Experiences: XR Heighten Sense of Immersion, Presence and Agency

The research discovered that immersive virtual learning environments offer unique and realistic learning experiences that are usually unachievable in real-life situations. This supports Bailenson's [27] concept that virtual learning offers distinct experiential learning compared to physical scenarios [28]. The participants shared their confidence in the captivating transfer of knowledge and the experiences generated by immersive virtual learning systems, leading to increased motivation. Similarly, Di Natale et al. [29] suggested that virtual learning environments promote contextualized learning and boost motivation, as well as transfer of knowledge. Participants' feedback confirmed that immersion levels in these environments depend on the technology employed, which can be high or low. Likewise, Makransky and Petersen [31] determined immersion levels depend on the hardware factors and the extent of sensory stimulation by the technology.

As per one EFL university professor, HMD and CAVE are deemed more immersive than desktop virtual reality environment. Likewise, Di Natale et al. [29] classified systems by immersion level: non-immersive (e.g., desktop

VR), semi-immersive (e.g., smart glasses/full dome), and fully immersive (e.g., HMDs). Similarly, Slater [38] stated that HMDs provide enhanced immersion with wider field of view and head tracking capabilities. Moreover, Queiroz et al. [21] described a system that tracks user's head movements in real-time, adjusting high immersive virtual environment to provide a comprehensive 360° view of digital content. Furthermore, Kaplan-Rakowski and Gruber [22] summarized that VR achieves high immersion through head-mounted devices, creating a spatially realistic 360° computer-generated virtual space. Additionally, Concannon et al. [39] Makransky and Lilleholt [19], and Lehikko [40] classified desktop virtual reality environments as non-immersive in their studies. The study findings revealed that utilizing HMDs in immersive VR enhances knowledge acquisition and skill development compared to less immersive desktop VR. A recent study by Wu et al. [30] compared immersive VR with desktop VR and traditional methods, finding immersive media to be more advantageous. The study recommended using HMDs for skill development and knowledge acquisition, as well as integrating immersive learning experiences and effective instructional design to improve cognitive processes and learning outcomes. Besides, Makransky and Mayer [28] cautioned that while immersive technology offers potential benefits, instructional designers and educators need to consider its specific advantages and disadvantages. However, Makransky et al. [41] and Parong and Mayer [23] identified cognitive load as a potential drawback when learning with immersive VR.

As per an educational technology specialist, learning in immersive environments provides benefits such as increased presence and agency. The level of immersion, whether non-immersive, semi-immersive, or fully immersive, impacts the psychological experience of presence in virtual environments, he mentioned. According to Johnson-Glenberg [42] and Makransky and Petersen [31], the level of psychological presence is the primary distinction between more and less immersive environments, regardless of other factors like interaction and agency. These study suggested that immersive environments offer advantages for lessons requiring psychological presence and agency, especially in highly immersive settings. Moreover, greater presence leads to deeper cognitive engagement, requiring increased cognitive effort for comprehension. Renninger and Hidi [43], Deci and Ryan [44], and Mayer [45] mentioned that the immersion principle in multimedia learning draws from theories of interest, motivation, and multimedia learning. It suggested that increased psychological presence, when used well in instructional design, can enhance learning outcomes. According to Mayer's [45] social agency theory, higher presence prompts students to engage in deeper cognitive processing and exert more effort to understand the material.

The Immersive Power of XR: Boosting Enjoyment, Interest, Motivation, and Self-Efficiency

Participants believe that utilizing immersive XR technologies in education will enhance students' engagement, enthusiasm, internal drive, and confidence in their ability to learn. Important studies have revealed that incorporating XR learning environments leads to a boost in learners' enjoyment, internal drive, sense of control, and confidence in their ability to learn. Studies conducted by Makransky et al. [46] and Queiroz et al. [21] support the fact mentioned by participants. Lehikko [40] and Reilly et al. [47] have suggested that utilizing immersive learning

environments can enhance learners' self-efficacy by offering realistic hands-on or observational experiences. This can lead to an increase in learners' confidence and belief in their own ability to succeed. Kaplan-Rakowski and Gruber [22] proposed that numerous language learners struggle with the drive to read intricate texts, but high-immersion VR has been increasingly observed as a highly motivating solution. A study conducted by Parong and Mayer [23] discovered that immersive VR improves learning through encouraging positive emotional and cognitive mechanisms, leading to improved performances on tests evaluating learning outcomes. Makransky et al. [46] conducted a study and noted that the immersive VR group performed significantly better compared to the text group on two transfer tests that involved solving problems in a physical laboratory setting (d = 0.54, d = 0.57). They also reported higher levels of enjoyment (d = 1.44), intrinsic motivation (d = 0.69), and self-efficacy (d = 0.60) within the immersive VR group.

Kaplan-Rakowski and Gruber [22] conducted a study in which they compared the motivation of English as a Second Language (ESL) learners while reading a story with subtitles in VR (experimental group) versus reading the same story screencast in two-dimensions (2D- control group). The Wilcoxon signed-rank test showed that learners' motivation in the VR group was significantly greater when compared to the control group. Queiroz et al. [21] conducted two studies in which they compared the impact of educational immersive VR to traditional videos on conceptual knowledge and self-efficacy. The findings revealed that in Experiment 1, the immersive VR group had a higher score on self-efficacy compared to the desktop group. Additionally, in Experiment 2, the relationship between condition and self-efficacy was mediated by learning agency, suggesting a potential mechanism that explains the impact of immersion on self-efficacy. Studies exploring the emotional effects of immersion in multimedia learning have shown that highly immersive environments lead to higher levels of presence [19] [41], enjoyment [24] [46] [48], and interest [25]. Wu et al. [30] conducted a recent meta-analysis that synthesized the results of 35 studies and found that highly immersive environments lead to greater levels of presence [19] [41], enjoyment [24] [46] [48], and interest [25].

Exploring Boundaries of Perception: XR Triggers the Illusion of Body Ownership and Embodiment in Virtual Environments

The study found the XR technology's potential to improve education through creating a virtual sense of embodiment and ownership of one's body, as participants showed captivation with the brain's distinction between their body parts and external objects, offering promise for educational uses. Numerous studies have also delved into the understanding of how the brain perceives and represents the body [49-51]. For example, 'Homuncular flexibility' refers to the brain's ability to adapt to different body arrangements and control an unfamiliar body. An expert in educational technology proposed that employing multisensory techniques may deceive the brain into perceiving a strong sense of possession over objects unrelated to their physical body. Likewise, Armel and Ramachandran [52] discovered that people can develop a strong attachment to an object, regardless of it not being a part of their body. Numerous research has been explored virtual embodiment technology and the elements that can generate illusions of body ownership [53][33][54][34][55]. For example, Guterstam et al. [53] employed a HMD to generate illusions of detachment by utilizing multisensory techniques.

An educational tech expert suggested simulating physical proximity through synchronized stimulation using a manikin in virtual settings, enhancing teacher-student engagement. Similarly, Kilteni et al. [56] induced an out-of-body illusion by stimulating participants' backs and stroking a manikin's back, leading to a feeling of ownership and presence in front of the manikin's body. An EFL university professor proposed creating an illusion for teachers and students, enabling them to perceive themselves from behind by synchronizing visual and tactile cues with their real physical body. In a similar manner, Penaud et al. [54] replicated this approach, with participants situated in front of video cameras that impersonated their own perspective. The experimenters stroked the participants' chests while simultaneously matching the strokes on the cameras. Consequently, participants experienced the sensation of being touched from behind their actual physical body. By combining visual and tactile cues in synchrony, the participants felt as though they were positioned behind their own body. Iriye and Ehrsson [32] discovered that individuals with a strong sense of ownership over their virtual avatar performed better in memory tasks and were more self-aware during recall. These findings emphasize the role of multiple senses and one's own body representation in forming episodic memories.

A futurist suggested that by utilizing specific technologies such as video cameras and HMDs, individuals can experience a sense of full physical ownership by observing a manikin body instead of their own during teaching and learning. This aligns with the beliefs of Slater and Sanchez-Vives [55], who argued that a wide field-of-view stereo HMD is necessary for individuals to see their virtual body with head tracking. Serino et al. [33] and Slater et al. [57] employed a HMD named Fakespace Wide5 to investigate full body ownership in virtual reality, wherein participants observed a virtual body in sync with their actual body, from a first-person viewpoint. The HMD featured wide field-of-view and head-tracking technology, enabling participants to perceive the virtual body coinciding with their real body's position when looking downwards. The futurist discussed viewing avatars from off-center and believed that even with different genders, people still feel connected to their virtual selves.

The Metamorphosis of the Self: XR Leads to Alterations in Attitudes, Behaviors, Cognition, and Physical Body

The study concluded that incorporating XR technology into education can create a feeling of owning a different body, leading to potential impacts on attitudes, behaviors, cognition, and physical body. According to Schöne et al. [34], virtual reality can potentially induce changes in attitudes, behaviors, brain function, and cognition by embodying a different body. In a study, Liu [35] explored the concept called the 'Proteus Effect' introduced by Yee and Bailenson [36]. The Proteus Effect suggests that people's behavior in virtual settings is influenced by their digital avatars. Liu's study found that individuals with attractive avatars were more likely to approach others, while those with taller avatars displayed more aggression. This shows how a person's digital representation affects their behavior online and offline. One of the university professors used a scenario to illustrate how changes in an individual's real body can impact their self-perception and attitudes. Beaudoin's study [58] discovered that stereotypes have an impact on how individuals perceive and behave towards their changed body ownership. That is, people tend to conform to societal expectations linked to the body they possess, which influences their actions and attitudes. Devine and Elliot [59]

suggested that teachers may show implicit bias against non-native English teachers, assuming that native English speakers are better at communication. The scenario described, where teachers exhibit implicit bias against non-native English speakers, is commonly referred to as language bias. The Proteus Effect, as described by Liu [35], is based on Self-perception Theory [60], which suggests that attitudes are formed through self-observation. Studies by Groom et al. [61] and Hershfield et al., [62] support this theory by placing participants in behavioral situations.

Participants believed that body ownership and agency over a virtual body goes beyond surface-level illusion, impacting cognitive processing and extending beyond mere perception. Banakou et al. [63] and Llobera et al. [64] suggested that the cortical body matrix plays a vital role in body ownership and agency over a virtual body. It influences cognitive processes and sensory signals related to body ownership and agency, maintaining consistency between different aspects of the self and the body representation. Changes in virtual body ownership can impact sensory perception and sense of self, emphasizing the significance of the cortical body matrix in cognitive processing and self-unity. Osimo et al. [65] found that using virtual reality to swap bodies with a virtual representation resulted in improved mood and potential effects on emotional well-being and cognitive processes like self-reflection. Additionally, research also looks at how body ownership illusions can impact the physical body. Overall, these findings show that altered body ownership can have a significant influence on individuals' psychological well-being and cognitive functioning. Banakou and Slater [66] discovered that perceiving and synchronizing movements with a virtual body creates a sense of control over speech. Voice frequency shifted higher after exposure in the synchronous condition, indicating a new motor plan for speech. This effect was not observed in the asynchronous condition.

Fig. 2 illustrates the depiction of future education in relation to the metaverse, as discussed by the participants.

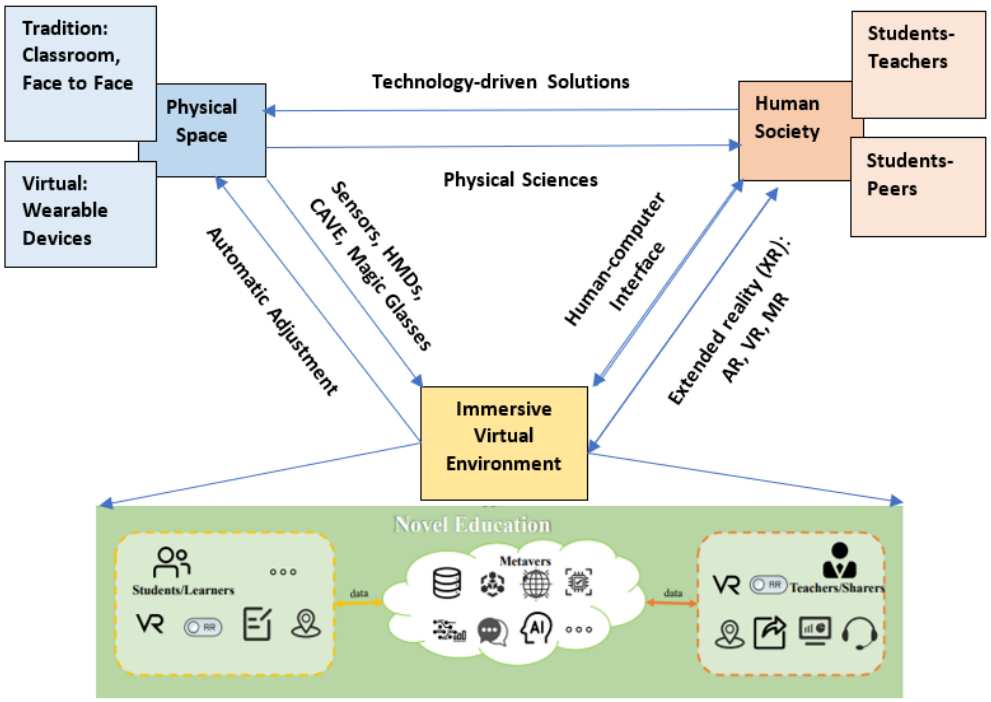

Fig. 2: Envisioning a portrayal of future education, integrating the metaverse

Conclusions

According to the literature, XR and 3D technologies have been crucial in driving advancements in various fields including medicine, chemistry, engineering, education, and others for numerous years. Previously, XR technologies were expensive and limited in use. Now, with advanced tech like high-resolution screens and motion sensors, XR is becoming more accessible for everyday use in various settings. XR is transforming life, work, and social interactions, making society increasingly reliant on technology. This uncertainty demands constant adaptation and lifelong learning. The world also faces other problems such as rising globalization, ongoing inequality, environmental deterioration, public health issues, and political upheaval. In order to successfully confront the global challenges and ensure success for everyone in the future, individuals must possess essential skills such as creative thinking, critical reasoning, metacognition, problem-solving abilities, effective communication, collaboration and understanding of global citizenship. It seems clear that there is an urgent need for a significant overhaul of the education system, in order to prepare young students for success in the face of the swift and continuous changes we are experiencing in technology, the economy, and society. Therefore, recreating the education system is necessary to achieve this goal.

It is important to acknowledge some limitations of this study. Firstly, the research focused solely on the educational applications of metaverse technology and did not explore its potential drawbacks or challenges. Future studies could delve into the potential risks or limitations associated with the integration of XR in educational settings. Additionally, the study relied on a specific sample size and context, thus limiting the generalizability of the findings. Further research with diverse populations and educational settings can provide a more comprehensive understanding of the implications of metaverse technology in education.

However, the findings of this study have important implications for educators and policymakers. Understanding the impact of metaverse technology on education can guide the development of pedagogical practices and curriculum design that effectively incorporate XR experiences. By embracing XR technology, educators can create immersive and interactive learning environments that cater to the needs and preferences of today's digital-native learners. Policymakers can provide support and resources for the integration of metaverse technology in educational institutions, fostering innovation and preparing students for the digital future. Additionally, the findings call for professional development programs to equip educators with the necessary skills and knowledge to effectively leverage metaverse technology in the classroom. The results of this study suggest that the metaverse has a significant influence on the future of education by providing more engaging and immersive environments. It not only presents exciting opportunities for educators, content creators, and developers of educational materials to enhance teaching and learning across various domains, but also prepares global communities for the future. Furthermore, it offers valuable insights for policymakers, educators, managers, leaders, practitioners, and stakeholders in higher education. This research is anticipated to serve as a credible resource for future inquiries in the field of education.

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Conflicts of Interest

The author has no conflicts of interest.

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AUTHOR(S) BIOSKETCHES

Esmaeel Ali Salimi is an Associate Professor of Applied Linguistics at Allameh Tabataba'i University. He has concentrated his teaching and research mostly on Second Language Acquisition, Critical Literacy, Critical Pedagogy and Teacher Education. He has published papers in TESOL Quarterly, Language Assessment Quarterly, Written Language and Literacy, Learning and Motivation, International Review of Applied Linguistics, ELT and Education and Information Technology and a few other national scholarly Journals. He has also been accepted as

a keynote speaker and a presenter in different national and international conferences.

Salimi, E. A. Associate Professor, Persian literature and Foreign Languages, Allameh Tabataba'i University, Tehran, Iran

easalimi@atu.ac.ir

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ORIGINAL RESEARCH PAPER

How Well do Self-Regulation and Engagement Predict Learning outcomes? Exploring Online English Classes in an Iranian University

R. Nejati

English Department, Faculty of Humanities, Shahid Rajaee Teacher Training University, Tehran, Iran

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* Corresponding author
reza.nejati@sru.ac.ir
(+98935) 2337344

ABSTRACT

Background and Objectives: Recognizing the unique requirements of online education is crucial due to its wide spread use. Self-regulation in learning seems essential for this instructional approach, as students and instructors are physically separated. To effectively manage their time, establish goals, and sustain motivation, individuals must adopt practical strategies. Active engagement in the learning process is also vital, requiring students to actively participate, contribute, and engage with instructors and peers. Assessing students' self-regulation and engagement can help educational managers and professors supervise the educational process and implement necessary measures when student participation is lacking. The objective of this study was to investigate how self-regulated learning and engagement contribute to outcomes of leaning as measured in terms of reading comprehension skills of Iranian students in online classrooms.

Materials and Methods: The study investigated research questions using two questionnaires and a test, namely, the Online self-regulation questionnaire (OSQ), the Online Student Engagement Scale (OSE), and the reading part of the Test of English as a Foreign Language. The self-regulation questionnaire had three constructs with 10 items each, while the engagement questionnaire had four constructs with 19 items. These scales were translated into Persian and sent to 345 students. Out of the 287 returned questionnaires, 21 were excluded due to inattention. The remaining 266 responses, along with their test scores, were analyzed statistically. Both the questionnaires and the language test were administered via the LMS in 2022.

Findings: The data underwent a rigorous process of statistical analyses to evaluate reliability, construct validity, and the relationships between variables. These analyses aimed to ensure the accuracy and robustness of the findings. To assess reliability, Cronbach's Alpha coefficients were calculated for three key variables: Engagement, Self-regulation, and Reading. The obtained coefficients were .89, .94, and .86, respectively. These values indicate high levels of internal consistency within each variable, suggesting that the measurement instruments used to assess these constructs were reliable. Construct validity was also examined through Root Mean Square Error of Approximation (RMSEA) values for Engagement, Self-regulation, and Reading. The reported RMSEA values were .08, .07, and .01, respectively. These values fall within an acceptable range, indicating that the measurement models adequately fit the observed data and supported the construct validity of the variables. All three variables (Engagement, Self-regulation, and Reading) exhibited statistically significant t-values, providing strong evidence that students' engagement, self-regulation, and reading ability were deemed satisfactory based on the collected data. The analysis revealed a significant positive correlation between regulatory engagement and reading comprehension. This finding suggests that higher levels of regulatory engagement are associated with better reading comprehension skills among students. Additionally, a regression analysis was conducted to explore the associations between specific factors and reading comprehension. The results indicated that both 'performance' and 'student-student interactions' had strong and positive associations with reading comprehension. The beta coefficients for these variables were 0.25 and 0.21, respectively. This implies that improvements in performance and increased student-student interactions are related to enhanced reading comprehension abilities.

Conclusions: The relationship between regulatory engagement and reading comprehension holds significant implications for educators and policymakers. Understanding this connection is essential to develop effective interventions and instructional approaches aimed at enhancing students' regulatory engagement abilities, ultimately leading to improved reading comprehension outcomes. However, it is important to acknowledge that the study conducted had certain limitations that restricted its scope and prevented a thorough examination of all potential factors influencing reading comprehension skills. To gain a more comprehensive understanding of the topic, future research should explore additional variables beyond regulatory engagement. For instance, considering the influence of cultural background on reading comprehension can provide valuable insights into how diverse learners may approach and interpret texts differently. Similarly, investigating various teaching methods employed in different educational settings can shed light on the effectiveness of specific instructional approaches in promoting reading comprehension. Furthermore, individual cognitive factors such as working memory and attentional control warrant attention in future studies. These cognitive processes play integral roles in reading comprehension, and exploring their impact can help identify strategies to support students with specific cognitive profiles or challenges.

NUMBER OF REFERENCES	NUMBER OF FIGURES	NUMBER OF TABLES
66	0	7

مقاله پژوهشی

خود تنظیمی و مشارکت چقدر نتایج یادگیری را پیش‌بینی می‌کنند؟ بررسی کلاس‌های آنلاین انگلیسی در یک دانشگاه ایرانی

رضا نجاتی

گروه آموزشی زبان انگلیسی، دانشکده علوم انسانی، دانشگاه تربیت دبیر شهید رجائی، تهران، ایران

چکیده

پیشینه و اهداف: شناخت الزامات منحصر به فرد آموزش برخط به دلیل گستردگی آن بسیار ضروری است. خودتنظیمی در یادگیری برای این رویکرد آموزشی ضروری است، زیرا دانش آموزان و معلمان از نظر فیزیکی از هم جدا هستند. افراد برای مدیریت موثر زمان خود، ایجاد اهداف و حفظ انگیزه، باید راهبردهای عملی اتخاذ کنند. مشارکت فعال در فرآیند یادگیری نیز مهم است و دانشجویان را ملزم به مشارکت فعال، مشارکت و تعامل با مربیان و همسالان می کند. ارزیابی خودتنظیمی و مشارکت دانشجویان می‌تواند به مدیران و استادان کمک کند تا بر روند آموزشی نظارت کنند و در مواقعی که مشارکت دانشجویان کم است، اقدامات لازم را انجام دهند. این مطالعه با هدف بررسی تأثیر مشارکت و خودتنظیمی یادگیری بر نتایج یادگیری درک مطلب دانشجویان ایرانی در کلاس‌های برخط انجام شده است.

روش‌ها: این پژوهش با استفاده از دو پرسشنامه و یک آزمون انجام شد. از پرسشنامه خودتنظیمی یادگیری، مقیاس مشارکت دانشجویی برخط و بخش خواندن آزمون زبان انگلیسی به عنوان زبان خارجی استفاده شد. پرسشنامه خودتنظیمی دارای سه سازه با ۳۰ گویه و پرسشنامه مشارکت چهار سازه با ۱۹ گویه بود. این مقیاس ها به فارسی ترجمه و برای ۳۴۵ دانشجو ارسال شد. از ۲۸۷ پرسشنامه برگشتی، ۲۱ پرسشنامه به دلیل بی دقتی پاسخ دهندگان حذف شدند. ۲۶۶ پاسخ باقیمانده، همراه با نمره آزمون آزمون آنها، مورد تجزیه و تحلیل آماری قرار گرفت. آزمون درک مطلب و پرسشنامه ها از طریق سامانه آموزش مجازی دانشگاه در پاییز ۱۴۰۱ اجرا شد.

یافته‌ها: برای ارزیابی پایایی، ضرایب آلفای کرونباخ برای سه متغیر کلیدی مشارکت فعال، خودتنظیمی یادگیری و خواندن و درک مطلب محاسبه شد. ضرایب به دست آمده به ترتیب ۰/۸۹، ۰/۹۴ و ۰/۸۶ بود. این مقادیر نشان می‌دهد که ابزار اندازه‌گیری مورد استفاده برای ارزیابی این سازه‌ها قابل اعتماد هستند. روایی سازه نیز از طریق مقادیر ریشه میانگین مربعات خطای تقریب (RMSEA) برای متغیرها بررسی شد. مقادیر RMSEA گزارش شده به ترتیب ۰.۰۸، ۰.۰۷ و ۰.۰۱ بود. این مقادیر در محدوده قابل قبولی قرار می‌گیرند که نشان می‌دهد مدل‌های اندازه‌گیری به اندازه کافی با داده‌های مشاهده‌شده تناسب دارند . هر سه متغیر (مشارکت فعال، خودتنظیمی و خواندن) مقادیر t آماری معنی‌داری را نشان دادند که بر توانی های فراگیران دلالت می کند. رابطه مثبت معناداری بین مشارکت نظارتی و درک مطلب مشاهده شد. این یافته نشان می‌دهد که سطوح بالاتر مشارکت نظارتی با مهارت‌های درک مطلب بهتر در بین دانش‌آموزان مرتبط است. علاوه بر این، تحلیل رگرسیون نشان داد که سازه های «عملکرد» و «تعامل دانشجو-دانشجو» با درک مطلب ارتباط قوی و مثبتی دارند. ضرایب بتا برای این متغیرها به ترتیب ۰.۲۵ و ۰.۲۱ بود. این نشان می‌دهد که بهبود عملکرد و افزایش تعاملات دانشجویان با افزایش توانایی‌های درک مطلب مرتبط است.

نتیجه‌گیری: رابطه بین مشارکت نظارتی و درک مطلب، پیام مهمی برای استادان و مدیران دارد. درک این ارتباط به منظور طراحی برنامه های مؤثر و رویکردهای آموزشی برای افزایش توانایی‌های مشارکت نظارتی دانشجویان ضروری است. با این حال، باید اذعان کنیم که مطالعه انجام شده دارای محدودیت‌های خاصی بود که دامنه آن را محدود

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* نویسنده مسئول
reza.nejati@sru.ac.ir
۰۹۳۵-۲۳۳۷۳۴۴

می‌کرد و از بررسی کامل همه عوامل مؤثر بر مهارت‌های درک مطلب جلوگیری می‌کرد. برای به دست آوردن درک جامع تر از موضوع، تحقیقات آینده باید متغیرهای اضافی فراتر از مشارکت نظارتی را بررسی کند. برای مثال، در نظر گرفتن تأثیر پیشینه فرهنگی بر درک مطلب می‌تواند بینش‌های ارزشمندی در مورد توانایی خواندن زبان‌آموزان ارائه دهد. به همین ترتیب، بررسی روش‌های تدریس مختلف می‌تواند اثربخشی رویکردهای آموزشی خاص در تقویت مهارت درک مطلب را روشن کند. علاوه بر این، عوامل شناختی فردی مانند حافظه فعال و کنترل توجه نقش مهمی در درک مطلب دارند و بررسی آنها می‌تواند به شناسایی راهبردهایی برای حمایت از دانشجویان کمک کند.

Introduction

After the coronavirus pandemic struck, the education system in Iran quickly adapted to the difficulties by implementing remote teaching techniques. What initially started as a temporary solution has now gained acceptance in the present education system. As online education persists, it is reasonable to admit the unique needs that come with this instructional approach. Self-regulation and engagement in learning are regarded as key factors that can significantly impact the outcomes of the learning process. When it comes to online education, these factors become even more critical.

With the physical separation between students and instructors in online classes, individuals must take practical measures to manage their time, set goals, and stay motivated. Self-regulation becomes crucial as students navigate virtual classrooms, ensuring they stay organized, meet deadlines, and take responsibility for their academic progress [1]. While traditional classroom settings often provide external structures to guide students, remote learning demands an increased focus on personal accountability.

According to King [2], engagement in the learning process is another vital aspect of online education. As students engage with course materials, they need to actively participate, contribute, and interact with their instructors and peers. Unlike face-to-face interactions, virtual classrooms necessitate alternative means of communication and collaboration, such as discussion boards, video conferences, and online forums. Students must employ active learning strategies, such as engaging in meaningful discussions, asking questions, seeking clarification, and sharing ideas, to maximize their understanding and enhance their overall educational experience.

Review of the Related Literature

Self-regulation in learning is considered one of the essential prerequisites for (online) education. Students may face challenges related to self-regulation in online classes. The immediate support and facilitation from teachers are not readily available in online education settings. Therefore, the development of independent learning skills becomes extremely important [3]. Consequently, self-regulatory abilities become highly important in online courses. Additionally, student engagement plays a pivotal role in maintaining their involvement in the process of learning and promoting effective learning [4,5].

Numerous theories exist to explicate the concept of self-regulation in learning in online instruction. Among them, the social cognitive theory put forward by Schunk and Usher in 2012 [6] and Usher and Schunk in 2017 [7] and the theory of information processing by Winne [8] are frequently employed. The information processing theory outlines four stages that govern the regulation of learning: comprehending the task, establishing goals and devising plans to accomplish them,

employing strategies, and engaging in metacognitive adjustments.

The social cognitive theory views the self-regulation of learning as an interactive process between individuals and their surroundings. It involves analyzing the learning task and setting learning goals in the initial phase called the forethought. This theoretical framework highlights the significance of motivation in pursuing educational objectives, as it impacts cognitive and metacognitive functions [7].

According to Azevedo, Johnson, Chauncey, and Burkett [9], advancements in technology have led to the development of means that empower learners to adjust and manage their own learning process. Azevedo and Aleven [10], Hadwin, Järvelä, and Miller [11], Winne [8], and Riemann and Bennert [12] argue for the regulation of learning, recognized as a fundamental principle in educational research.

While there are cultural variations in the finer aspects of self-regulated learning, the fundamental components remain consistent across cultures. In essence, self-regulation of learning holds universal importance for school engagement and academic achievement [13]. According to Zhu, Valcke and Schellens [14], there is a direct connection between specific self-regulation tactics and the enhancement of deep learning. The utilization of strategies of learning self-regulation is also linked to psychological factors such as academic self-concept and self-efficacy [15]). Huang and Prochner [16] suggest that among Asians, family dynamics, teaching styles (comparative, authoritarian, and Western), and closeness between family members play central roles in the adoption of self-regulated learning. Furthermore, in certain cultures, family influence is related to "trustworthiness," or " failure anxiety " serving as a positive factor for engagement in the process of learning [17].

The impact of self-regulation in learning on educational success has been substantiated by Cengiz-Istanbullu and Sakiz [18] as well as Davis and Hadwin [19]. Boekaerts, Pintrich and Zeidner [20] argue that self-regulation in learning can be assessed through multiple factors, such as goal setting, goal control, and outcome evaluation. These factors significantly influence students' capacity to effectively manage their learning processes and achieve favorable academic results. By establishing explicit goals, students can establish a sense of purpose and direction, enabling them to proceed with their learning more effectively.

Wandler and Imbriale [21] observed a strong correlation between self-regulation and academic achievement in online learning environments. Therefore, it seems crucial for educators to equip students with the essential resources to develop self-regulated learning strategies. These authors argue that incorporating diverse strategies within online classes can improve students' adoption of strategies of learning self-regulation. Ensuring that online learning environments are structured to endorse self-regulated learning is also a significant consideration in fostering motivation and success among students.

Numerous studies have been carried out to investigate the concept of self-regulated learning in online instruction. Examples include research by Chiu, Liang, and Tsai [22], Chen and Huang [23], and Dunn, Rakes, and Rakes [24]. These studies have demonstrated that self-regulated learning holds significance not only in traditional face-to-face education but also in the context of online classes. The number of scientific investigations concerning self-regulated learning in online settings has increased [25-27]. Zhang et al. [28] developed a scale consisting of six factors to assess the process of learning English in an online setting. These factors include goal establishment, time

management, structuring the learning environment, seeking assistance, employing task strategies, and self-assessment.

Research indicates that learners exhibit positive attitudes towards online learning [27], particularly in the domain of English language acquisition [28]. Students who possess strong self-regulation abilities demonstrate competence in effectively controlling their focus, memory utilization, and impulse restraint [29]. The effectiveness of online language learning for language learners greatly depends on self-regulated learning, as highlighted by Cho and Shen [30] and Li et al. [31]. Giving priority to self-regulated learning is beneficial for it allows learners to enthusiastically engage in the learning process and cultivate favorable habits for acquiring language skills.

Contrasted with traditional classroom learning, online learning requires students to possess a higher degree of self-reliance. However, the online platforms have the advantage of tracking learners' progress (e.g., content learning and duration of online presence) and providing precise feedback to facilitate self-regulated learning. Consequently, understanding learners' self-regulation in online second language learning holds significance.

According to Viberg et al. [32], self-regulated learning is central for determining both the outcomes of learning and academic satisfaction, while also providing learners with the ability to shape their future educational and professional trajectories. Crucially, it is worth noting that self-regulated learning has the potential to be instructed and managed by learners themselves [33,34]. Consequently, it becomes vital for educators to provide assistance and guidance in promoting their students' self-regulated learning.

Thomas and Rose [35] demonstrated that employing language learning strategies significantly influences an individual's ability to proficiently self-regulate themselves and successfully acquire a second language. Dörnyei [36] holds that there is ongoing debate regarding the definition of language learning strategies and points out the lack of precision in measurement methods. In his model, he categorizes self-regulated learning abilities into five specific types: commitment control, metacognitive control, satiety control, emotion control, and environmental control. Expanding on this framework, Tseng, Dörnyei and Schmitt [37] created a survey known as the "Self-Regulatory Ability of Vocabulary Learning" to overcome the constraints of conventional language learning strategies. The aim was to evaluate students' comprehensive aptitude for self-regulated learning instead of solely concentrating on specific strategies.

There seems to be a positive correlation between academic success and self-regulated learning, particularly in relation to metacognitive regulatory actions such as monitoring and planning. Having a strong ability to engage in self-regulated learning is advantageous for L2 learners in online learning settings [38].

The ability of second language learners to control their learning in online environments is impacted by external elements, including guidance and intervention. It is essential to support students in cultivating this ability because those who can effectively self-regulate their learning tend to attain greater academic achievements. Research has shown that providing learners with guidance on learning strategies can improve both their self-regulation skills and academic performance [39].

According to Cleary et al. [40] and Cleary and Zimmerman [41], there are conceptual

similarities between models of student engagement and self-regulated learning. In terms of engagement, cognitive involvement encompasses motivational and regulatory procedures such as establishing goals, monitoring progress, and evaluating performance. According to Pohl [42], the concept of cognitive engagement denotes the level of commitment students demonstrate towards their learning, recognizing its importance, exerting effort to learn, and employing effective strategies to understand content, complete assigned tasks, acquire skills, and achieve their objectives (p. 254).

Lewis et al. [43] believe that engagement encompasses the level of cognitive processes, emotions, and activities involved in the process of learning (p. 251). In their study, Connell et al. [44] classified student engagement into three distinct dimensions: behavioral engagement, which relates to perseverance, effort, and focused attention during learning; emotional engagement, which pertains to curiosity and enthusiasm for learning; and psychological engagement, which involves embracing challenges, independent thinking, and active participation in educational initiatives. Meanwhile, Reschly et al. [45] claimed that academic participation entails factors such as grades achieved and the time dedicated to academic tasks such as attending lectures, completing tasks, and participating in group activities.

According to Khan, Egbue, Palkie and Madden [46], instructors encounter numerous obstacles when attempting to enhance student engagement in online instruction. The primary challenge lies in their inclination to employ traditional teaching methods within the online class setting, without adapting or modifying their approaches. In online instruction, instructors are required to assume a broader role beyond lesson design. They must effectively communicate their instruction methods and educational expectations to students, provide feedback, and rectify errors [47].

According to Umbach and Wawrzynski's study [48], it was found that students who faced academic challenges posed by their professors demonstrated higher levels of engagement in the learning process. Furthermore, Fisher [49] suggests that students' prior experience in online classes contributes to their engagement in such courses. This implies that students who lack previous exposure to online classes may struggle to actively participate in the class. Fisher also notes that the majority of students prefer traditional in-person teaching because it is the sole instructional approach they have been exposed to during their high school or early college experiences.

In their studies, Taplin [50] and Hoffman and Ritchie [51] have reached the conclusion that certain students struggle to transition from passive, teacher-dependent learning habits. These students often experience anxiety when confronted with changes in teaching methods, placing blame on their instructors. Additionally, Layne et al. [52] claimed that the individual characteristics of students play a crucial role in their ability to sustain their studies. Factors such as self-efficacy and resilience can significantly impact their capacity to persevere and excel in their academic pursuits.

The success of online education depends on various educational factors and the adaptability of instructors to modify teaching practices, manage time effectively, and so on. Students expect that instructors will establish a sense of community in online learning similar to traditional classrooms, thus enhancing their learning experience.

According to the findings of Allen and Zhang [53], students in online education need to cultivate certain skills and traits such as a strong desire for learning, building a solid knowledge foundation and self-perception, mental readiness for learning, problem-solving abilities, and self-regulation. Among adult learners, effective management of learning and active involvement play a prominent role, ultimately boosting their motivation. However, Phillips [54] offers a contrasting perspective by suggesting that external mechanisms for learning management should be established to facilitate student engagement.

The Motivated Learning Strategies Questionnaire, designed by Pintrich, et.al [55], is the most commonly utilized research tool for investigating self-regulated learning. Several research studies, including Hodges and Kim [56], Klingsieck et. al, [57], and Cho and Shen [30] have utilized the aforementioned questionnaire in their investigations. However, Cho, and Cho, [1] argued that questionnaires made for traditional classroom settings may not be suitable for online courses since they might not sufficiently evaluate the distinctive characteristics of online learning. Furthermore, such questionnaires may lack validity for online students. To address these concerns, Cho, and Cho, [1] conducted a thorough review of the literature and developed a new standardized tool known as the online self-regulation questionnaire. This questionnaire has been utilized in the current research; further details can be found in the research instrument section.

As stated by Dixon [58], engagement encompasses various aspects such as perception, cognition, behavior, and communication with others. It involves investing time, energy, and effort in the learning process, along with the student's subjective experience of it. To gauge these dimensions, the "scale of engagement in online education" aims to assess students' activities, their perception of learning, and their interactions with course content, instructors, and peers in terms of skills, class involvement, performance, and emotional responses. This questionnaire has been utilized in the current study; its details can be found in the instruments section.

With the rise of online education, it is crucial for educational institutions to modify their methods and strategies to better cater to students' needs. According to Yuan and Kim [59], educators should aim for collective education in the online environment to foster stronger relationships between professors and students. This approach enhances student performance and academic satisfaction.

This study explores the concept of self-regulation and engagement in learning and their significance in online English classes. The article provides an assessment of students' level of engagement and self-regulation in learning and academic progress to provide more information about the participants of this study. More specifically, the main objective of this study is to investigate the function of learning self-regulation and engagement in the reading comprehension abilities of Iranian students in online classes. To achieve these objectives, the following questions are addressed.

Is the students’ level of engagement satisfactory?

Is the students’ level of self-regulated learning satisfactory?

Is the students' academic progress, as reflected in reading comprehension skills, satisfactory?

To what extent can self-regulated learning and engagement serve as predictors of learning outcomes?

In what follows, the method of the study including participants, instruments, and the procedure is detailed.

Method

Participants

The study involved an available sample of 345 students, ranging in age from 19 to 23, who were registered at a university in Tehran for a general language course. Among the enrolled participants, 287 students completed the questionnaires in their entirety. However, during the initial data screening process, it was observed that 21 of the questionnaires were either incomplete or contained inaccurate responses. These inadequately filled questionnaires were deemed unsuitable for analysis due to the potential biases they could introduce. A total of 266 complete and accurate responses were available for detailed analysis.

Instruments

The researcher aimed to collect data to investigate the significance of self-regulation and engagement in the learning process. To achieve this objective, two meticulously designed questionnaires were utilized: the 'Online Self-regulation Questionnaire' containing 30 items, and the 'Online Student Engagement Scale' consisting of 19 items. Additionally, the researchers incorporated the reading section of the widely acknowledged TOEFL test, which encompassed a total of 40 items. The selection of these instruments was based on their proven dependability and accuracy in measuring self-regulation, engagement, and reading skills in the online learning setting.

The online self-regulation questionnaire (OSQ)

Cho and Cho [1] developed this questionnaire in 2017. It consisted of 30 items divided into three constructs. The first construct (items 1 to 11) focused on how students dealt with the course materials. The second construct (items 12 to 20) examined students' responsibility for interactions, collaboration, and communication with their instructors. The third construct (items 21 to 30) explored students' positive involvement in peer interactions, group discussions, and collective learning. To evaluate the participants' responses, this questionnaire utilized a Likert scale consisting of seven points. The scale ranged from 1, representing "not at all true of me," to 7, representing "very true of me."

To provide validity evidence, the original authors conducted a study employing a sample size of 799 students from two Midwestern universities. These students were enrolled in online courses across various disciplines, including mathematics, politics, economics, history, psychology, and physics. The questionnaire was shown to be reliable by the authors using Cronbach's alpha coefficient, which had a value greater than 0.9, indicating a strong level of internal consistency.

Online Student Engagement Scale (OSE)

The study employed the Online Student Engagement Scale, which was created by Dixon in 2015 [58]. The measure consisted of 19 statements that encompassed different engagement-related behaviors. Participants were asked to use a 7-point Likert scale to indicate the degree to which each statement reflected their personal experiences. The scale ranged from 1, indicating "not at all characteristic of me," to 7, representing "very characteristic of me."

The questionnaire designer assessed engagement by dividing it into four dimensions. The first dimension, Skills, looked at behaviors such as note-taking. Items 1, 3, 4, 5, 6, and 7 focused on participants' active involvement in acquiring and organizing information. The

second dimension, Emotional Engagement, explored participants' intrinsic motivation and desire to learn. Items 2, 8, 9, 10, 11, and 19 measured emotional investment, curiosity, and enthusiasm. Participation formed the third dimension, emphasizing involvement in discussions and forums. Items 12, 13, 14, 17, and 18 evaluated collaborative learning, idea sharing, and peer interaction. The fourth dimension, Performance, focused on achieving high grades. Items 15 and 16 assessed academic accomplishment and motivation to excel.

The reliability of the assessment tool was evaluated by the questionnaire designer using a group of 34 students (11 males and 23 females) from various advanced communication courses. The students voluntarily completed the OSE survey and allowed their instructor to share information about their online activities.

Once students finished the survey and the semester concluded, instructors exchanged tracking data for analysis. The data encompassed an elaborate log of students' learning engagements throughout the semester, including the quantity of emails, discussions, and assignments they accessed, as well as the number of files, content pages, and web pages they viewed. Additionally, it documented their interaction with the material by means of metrics such as the number of discussions initiated, emails sent, assessments finished, and assignments turned in.

The Cronbach's alpha for this study was .86, suggesting strong internal consistency of the instrument. The observed behaviors exhibited a noteworthy correlation with the OSE scale, offering robust evidence for the scale's validity as an indicator of student engagement.

Reading Comprehension Test

The TOEFL's reading section served as a tool for evaluating students' reading comprehension abilities. It encompasses an array of micro-skills such as recalling the meanings of words to ensure a firm grasp of vocabulary, comprehending words in the context of the given text, and understanding the interplay between textual and external sources. Furthermore, the TOEFL reading section focuses on higher-level skills, such as making inferences based on the text, identifying synonyms, and efficiently searching for specific information. It also tests the students' ability to comprehend references and grasp grammatical relationships within the text. In addition, the test assesses the ability to utilize skimming and scanning techniques effectively to navigate through the text and locate relevant information. Lastly, the section delves into the students' ability to recognize the author's style and tone, thereby enabling a deeper understanding of the text's intended message.

Procedure

To assess the learning outcome of students in the general English course, the TOEFL reading section was administered to the students. This test was conducted through the virtual education system of the university, which is a convenient and accessible platform for students to participate. The students were given forty minutes to do the test. To gather data for research objectives, the questionnaires were adapted using Google Forms and sent to the students in autumn 2022. The questionnaires comprised a series of statements, allowing students to express their agreement or disagreement on a scale of 1 to 7.

To confirm the respondents' comprehension of the questionnaire items, the researcher utilized Persian versions of the questionnaires. These questionnaires had not been previously published or accessible in Iranian research journals, necessitating the researcher to independently translate them. To guarantee

precision, two professors proficient in both languages conducted back-translations of the questionnaires.

Out of the 345 students who received the questionnaires, 287 students completed and submitted them. However, upon closer examination, it was discovered that 21 responses exhibited patterns that rendered them unreliable for analysis. These patterns included consistently selecting the neutral option or choosing the same response for every question. Consequently, these 21 responses were excluded from the subsequent analysis, leaving a total of 266 valid responses.

The remaining 266 responses of the students, along with their reading comprehension scores were included in the data analysis. By combining the questionnaire responses and the actual performance in the TOEFL reading section, researchers aimed to gain insights into the association between students' self-reported perceptions and their reading comprehension abilities. This approach allowed for a more robust and nuanced understanding of the students' language ability levels within the context of the general English course.

Design

The study's design is descriptive correlational, to investigate the connections between regulatory engagement and learning outcomes. This approach enables the researcher to consider the associations between these variables and obtain a better understanding of their nature and strength.

Results and Findings

As stated earlier, the study aimed to investigate the relationship between self-regulation of learning and engagement with reading comprehension among Iranian students in online classes. Data was collected through questionnaires assessing self-regulation of learning and engagement, as well as the TOEFL reading section. Statistical analysis using SPSS and Amos included reliability, factor analysis, one-sample t-test, correlation, and regression analyses. Here are the results.

Before addressing the research questions, it is essential to provide an evaluation of the psychometric features of the measures used in the study. The psychometric properties, specifically reliability and construct validity, play a significant role in establishing the credibility and accuracy of the measurements employed. In this regard, the reliability and construct validity of the instruments utilized in the study are reported.

Cronbach's Alpha coefficient was calculated for each measure to evaluate the reliability of the instruments. As depicted in Table 1, the obtained Cronbach's Alpha coefficients for Engagement, Self-regulation, and Reading test were found to be .89, .94, and .86, respectively. These coefficients suggest that the instruments exhibit satisfactory levels of reliability. This suggests that the items within each measure exhibit a high degree of correlation, which signifies robust internal consistency and reliability of the instruments.

The assessment also included an evaluation of construct validity, which examines how accurately the instruments measure the intended constructs. Construct validity provides evidence that the instruments are indeed measuring the theoretical concepts they are designed to capture. It is important to note that construct validity was evaluated through confirmatory factor analysis.

Table 2 presents the findings regarding construct validity. The RMSEA values for

Engagement, Self-regulation, and Reading are reported as .08, .07, and .01 respectively, indicating satisfactory results. According to Browne and Cudeck [60], models with RMSEA below .08 and PCLOSE of .5 or higher are considered adequate.

Now that the questionnaires and the reading test have been thoroughly assessed for their reliability and validity, we can confidently proceed with addressing the research questions central to our study.

One-sample t-test technique was employed to address the first three research questions that are restated below for clarity. By employing this method, researchers were able to determine whether there were notable distinctions between the mean value of the observed sample and a presumed population mean.

Is the students' level of engagement satisfactory?

Is the students' level of self-regulated learning satisfactory?

Is the students' academic progress, as reflected in reading comprehension skills, satisfactory?

To address the aforementioned research questions, a benchmark of achieving at least 70% of the total scores was set. The statistical significance of the variables in the study was determined by calculating the t values, which are presented in Table 3. The results revealed that all of the variables, namely Engagement, Self-regulation, and Reading, had statistically significant t values (Engagement: t (265) = 4.45, P = .00; Self-regulation: t (265) = 6.56, P = .00; Reading: t (265) = 2.96, P = .02). This outcome holds significant implications as it provides strong evidence that students' engagement, self-regulation, and reading ability were deemed satisfactory based on the data collected and analyzed in the research. In other words, the results suggest that students displayed encouraging levels of involvement, effective self-regulation, and proficient reading skills, which attest to their overall academic performance and competence in these domains.

Table 1: Reliability of the Instruments

Instrument	Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
Engagement	.89	.89	19
Self-regulation	.94	.94	30
Reading	.86	.87	40

Table 2: Model Fit Statistics for Engagement, Self-regulation and Reading Comprehension

Instrument	RMSEA	LO 90	HI 90	PCLOSE
Engagement	.08	.07	.09	.5
Self-regulation	.07	.06	.09	.5
Reading	.01	.01	.02	1.00

Table 3: One-sample t-test for Engagement Self-regulation and Reading Comprehension

Instrument	Test Value	t	df	Sig. (2-tailed)	Mean Difference	95% Confidence Interval of the Difference	
						Lower	Upper
Engagement	%70	4.45	265	.00	4.00	2.23	5.78
Self-regulation	%70	6.56	265	.00	9.66	6.76	12.55
Reading	%70	2.96	265	.02	.44	.06	.81

The major research question of the current study was:

To what extent can self-regulated learning and engagement serve as predictors of learning outcomes?

The researcher employed standard linear regression to assess the predicting power of self-regulated learning and engagement in reading comprehension of the learners. To assess the multicollinearity among the independent variables, their correlation was examined to find a coefficient of 0.82 (Table 4). According to Pallant's [61] guideline, a bivariate correlation of .7 or higher between independent variables can create challenges when testing and interpreting regression coefficients. She suggests creating a 'composite' variable from the scores of the two strongly correlated variables.

Table 4: Correlations between the variables

	Reading	engagement	Self-regulation
Reading	1	.42	.46
engagement	.42	1	.82
Self-regulation	.46	.82	1
Sig. (2-tailed)	.00	.00	
N	266	267	266

It is worth mentioning that recent studies by Cleary et al. [40] and Pohl [32] have shed light on the interconnectedness between student engagement and self-regulated learning. These two constructs share common elements that contribute to academic success and effective learning outcomes. The shared elements encompass various aspects such as goal setting, progress monitoring, performance assessment, investing effort in learning, employing effective strategies, completing assigned tasks, acquiring skills, and achieving objectives.

Given the significant overlap between these constructs, it becomes theoretically feasible to develop a composite variable that combines the dimensions of self-regulation and engagement. This composite variable, often referred to as 'regulatory engagement,' as termed by Cleary and Lui [62], integrates the essential components of both constructs into a single measure. By merging these variables, researchers and educators can gain a more comprehensive understanding of students' learning experiences and their level of involvement in the learning process.

The concept of regulatory engagement holds great potential for educational research and practice. It offers a holistic perspective on the dynamic interplay between students' self-regulated learning strategies and their active engagement in educational activities. Moreover, this composite variable provides a valuable framework for designing interventions and instructional approaches aimed at promoting effective learning environments and enhancing students' motivation, metacognition, and overall academic achievement.

To generate a composite variable, the scores of the two variables were first converted into Z scores, which standardized

the data and allowed for meaningful comparisons. This transformation ensured that both variables were on the same scale, eliminating any potential bias caused by differences in their original measurement units. Once the Z scores were obtained, they were merged using a specific statistical procedure outlined in Tabachnick and Fidell's [63] work. This merging process involved combining the Z scores from each variable to create a single composite score that captured the underlying relationship between the two variables. By integrating the information from both variables into a composite measure, the researcher aimed to get a more complete understanding of the phenomenon under investigation. Hence, a new research question was formulated as below.

Does regulatory engagement have a significant correlation with reading comprehension?

To respond to this question, a bivariate correlation analysis was conducted. The objective of the study was to ascertain the level of connection between these variables and provide insights into their interrelationships. The findings from this analysis are outlined in Table 5.

The findings from the analysis reveal a noteworthy positive association between the variables (r=0.46, n=266, p=0.00). This correlation coefficient indicates a moderate level of association, as outlined by Cohen [64, pp. 79–81]. Furthermore, the value of R^2, which measures the percentage of variance explained by the composite variable, is 0.21. This indicates that the amalgamation of the variables accounts for approximately 21 percent of the variation observed in reading comprehension. While there may be other factors influencing reading comprehension beyond those considered in this study, the composite variable constructed from the examined variables holds substantial explanatory power in understanding the variance in reading comprehension outcomes.

Table 5: Correlation between reading and Regulatory Engagement

	Reading	Regulatory Engagement
Reading	1	.46
Sig. (2-tailed)	.00	.00
N	266	266

Since regulatory engagement encompasses multiple dimensions, it can be beneficial to break it down into its constituent components to get a deeper appreciation of the research findings. This approach allows for a more subtle interpretation of the data. The newly proposed variable comprises various elements, including 'skills,' which refers to the mastery and application of knowledge; 'emotional engagement,' which pertains to the emotional connection students have with the subject matter; 'participation,' which involves active involvement and contribution in learning activities; 'performance,' which gauges the level of achievement or success in academic tasks; 'student-Content interaction,' which examines how students interact with the course material; 'student-teacher interaction,' which explores the quality and extent of student-teacher relationships; and 'student-student interaction,' which assesses the collaborative interactions among students. For additional details on these components, please refer to the 'instruments' section of the study, where comprehensive information is provided. Here, the reader can find a thorough description of the outcomes derived from the regression analysis.

The results presented in Table 6 provide compelling evidence of the statistical significance of the overall regression analysis. The coefficient of determination (R^2) value of

0.26 indicates that the regulatory engagement components included in the model explain approximately 26 percent of the variability observed in reading comprehension. This finding is highly encouraging and suggests that these components play a substantial role in influencing individuals' ability to comprehend written material.

Furthermore, the model was deemed statistically significant based on the F-statistic (F = (7,258) 13.2, p = 0.00). This indicates that the relationship between the regulatory engagement components and reading comprehension is not merely due to chance. Instead, it signifies a meaningful and reliable association between these variables.

To gauge the multicollinearity among the major variables, a thorough examination of their correlation was conducted. The analysis revealed that the correlation coefficients fell within the range of .3 to .69, indicating no significant evidence of multicollinearity. Furthermore, the Variance Inflation Factor (VIF) values were found to be less than 3, which further supports the conclusion that multicollinearity is not a concern here.

To guarantee the precision of the regression model, various additional diagnostic tests were conducted. Outliers were identified and assessed to determine their impact on the results, and it was determined that they did not exert undue influence on the findings. The assumption of normality was examined, and the data exhibited a satisfactory distribution, indicating that the residuals followed a normal pattern.

Additionally, the assumption of linearity was examined, and it was determined that there exists a satisfactory linear relationship between the regulatory engagement and reading skills. Homoscedasticity, which refers to the equal variance of the residuals across all levels of the predictors, was also evaluated and found to be satisfactory.

Finally, the independence of residuals was assessed, and no significant autocorrelation or patterns were detected, suggesting that the residuals were independent of each other.

A summary of these diagnostic tests and their results can be found in Table 7, which provides a complete overview of the assessment of multicollinearity and the various assumptions underlying the regression model.

Table 6: Model Summary for Components of Regulatory Engagement

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics				
					R Square Change	F Change	df1	df2	Sig. F Change
1	.51	.264	.24	4.81	.264	13.20	7	258	.000

Table 7: Regression Coefficients of Components of Regulatory Engagement and Reading Comprehension

	Unstandardized Coefficients		Standardized Coefficients			Correlations			Collinearity
Model	B	Std. Error	Beta	t	Sig.	Zero-order	Part	Tolerance	VIF
(Constant)	11.48	2.18		5.26	.00				
skills	.10	.08	.10	1.26	.20	.36	.06	.45	2.21
emotion	.02	.07	.02	.25	.80	.30	.01	.47	2.11
participation	-.05	.07	-.05	-.66	.50	.33	-.03	.48	2.07
performance	.71	.19	.25	3.68	.00	.42	.19	.61	1.62
Student-Content	-.00	.05	-.01	-.16	.86	.35	-.00	.34	2.87
Student-Teacher	.07	.04	.11	1.52	.12	.40	.08	.48	2.04
Student-Student	.12	.04	.21	2.92	.00	.40	.15	.51	1.94

The findings presented in Table 7 provide evidence that both 'performance' and 'student-student interactions' significantly contribute to predicting reading comprehension. The findings of the regression analysis demonstrated that 'performance' had a beta coefficient of 0.25 (p=0.00), indicating a robust and positive association with reading comprehension. Similarly, 'student-student interactions' exhibited a beta coefficient of 0.21 (p=0.00), suggesting a noteworthy and positive connection to reading comprehension.

Examining the part correlations, it was observed that 'performance' had a correlation of 0.19 with reading comprehension, while 'student-student interactions' had a correlation of 0.15 with reading comprehension. These values designate the strength of the relationships between these variables and reading comprehension.

To further understand the impact of these predictors on reading comprehension, the squared values were calculated. The squared value of 'performance' was found to be 0.036, meaning that performance explains 3.6% of the variance in reading comprehension scores. Similarly, the squared value of 'student-student interactions' was 0.022, indicating that student-student interactions explain 2.2% of the variance in reading comprehension scores.

Discussion

The current study's discoveries greatly enhance our understanding of the subject matter by revealing the complex connection between regulatory engagement and reading comprehension abilities. By examining these variables in detail, this research underscores their importance in shaping individuals' ability to comprehend written texts effectively. These results not only reinforce the conclusions drawn by previous studies such as Cengiz-Istanbullu and Sakiz [18], Chen and Huang [23], Chiu, Liang, and Tsai [22], Davis and Hadwin [19] and Dunn, et.al [24] but also provide additional evidence supporting the claim that self-regulation plays a pivotal role in achieving educational success.

Furthermore, the outcomes of the current study align with the perspectives put forth by Dent and Koenka [41], King [2], and King and Ganotis [17], emphasizing the crucial role of engagement in the learning process, particularly in the context of online education. These researchers argue that active involvement and participation in the learning experience are essential elements for effective online education. The findings of this study lend further support for this conviction,

highlighting the significance of student engagement as a key factor in promoting successful outcomes in online educational settings. Overall, this research enhances existing literature and emphasizes the importance of regulatory engagement for improving reading comprehension and online learning.

The significant correlation between the different aspects of regulatory engagement and reading comprehension underscores the paramount importance of fostering effective regulatory techniques in learners. This connection emphasizes that the skills to regulate one's cognitive processes, such as attention, self-monitoring, and goal setting, play a pivotal role in enhancing reading comprehension abilities. By recognizing this relationship, educators and policymakers can harness these findings to design targeted interventions and innovative teaching methods aimed at promoting and enhancing students' regulatory engagement skills.

By incorporating strategies that explicitly teach students how to regulate their cognitive processes during reading tasks, educators can empower learners to play active roles in their learning. These interventions may include teaching metacognitive strategies, such as self-questioning, summarizing, and monitoring comprehension, which have been shown to improve reading comprehension outcomes. Additionally, educators can integrate explicit instruction on self-regulation techniques, such as setting goals, managing time effectively, and utilizing effective study strategies, to equip students with the necessary tools to navigate complex texts and extract meaning from them.

Furthermore, policymakers can use these research findings to inform educational policies and initiatives that prioritize the development of regulatory engagement skills. By integrating these principles into curriculum frameworks, policymakers can ensure that schools provide chances for students to practice and refine their regulatory techniques across various subjects and grade levels. This holistic approach to education recognizes that regulatory engagement is not limited to reading comprehension alone but extends to other academic domains and real-life contexts.

Ultimately, by adopting an approach that prioritizes the cultivation of effective regulatory techniques, learners can develop stronger reading skills, succeed academically, and thrive in various areas of their lives. The capability to regulate one's cognitive processes not only enhances reading comprehension but also equips individuals with valuable skills for lifelong learning and success. By inspiring students to play an active role in controlling their learning experiences, educators and policymakers can foster a generation of independent, critical thinkers who are well-equipped to navigate the complexities of the modern world.

Overall, the conclusions of this study underscore the significance of two key factors, namely 'performance' and 'student-student interactions,' in determining reading comprehension. In addition to the present study, Kreijns et al. [65] also recognized the value of interaction among students in online learning environments. They argued that the effectiveness of online learning is enhanced when student groups cultivate an environment characterized by mutual trust, as this fosters a favorable atmosphere for learning.

While both performance and student-student interactions contribute significantly to reading comprehension, it is worth noting that 'performance' appears to exert a slightly stronger influence. This factor encompasses aspects such as getting good marks and good performance on tests and quizzes. It explains a larger percentage of the variance in reading

comprehension compared to student-student interactions. These results suggest that while collaborative interactions among students are valuable, individual academic achievement plays a more prominent role in predicting reading comprehension outcomes.

It seems that performance, characterized by improved academic achievement and cognitive abilities, has positively influenced self-regulation or motivation, leading to a subsequent enhancement in reading comprehension skills. In essence, self-regulation and/or motivation may serve as mediating factors in this relationship, acting as catalysts for the observed improvements. However, due to the complexity of these interactions and the variability across individuals, further comprehensive research is required to delve into the intricacies of this mediation effect. By conducting additional studies, we can gain a deeper understanding of how self-regulation and motivation contribute to enhanced reading comprehension and unveil potential strategies to optimize educational outcomes.

Conclusions

The significant correlation between the different aspects of regulatory engagement and reading comprehension highlights the crucial role of cultivating effective regulatory techniques in learners. These findings can be utilized by educators to create interventions and instructional approaches that encourage and improve students' regulatory engagement abilities. This, in turn, will enable learners to become more skilled readers and provide them with the essential resources for academic success and beyond.

Prioritizing self-regulated learning is advantageous for the learners as it empowers them to enthusiastically participate in the learning process and develop positive habits for acquiring language skills. In comparison to traditional classroom learning, online learning necessitates a greater level of self-dependence from students. Nevertheless, the online platform offers the benefit of monitoring learners' progress (such as content comprehension and time spent online) and offering specific feedback to enhance self-regulated learning.

However, due to the study's limited scope, it was unable to examine other factors that may impact reading comprehension skills. Consequently, it may be necessary to conduct more studies to investigate other variables that might impact reading comprehension and build upon the existing discoveries. For example, examining the effects of cultural background, teaching techniques, and individual variations in cognitive abilities such as working memory capacity and attentional control on reading comprehension could offer a more thorough comprehension of the topic. Additionally, delving into the influence of technological advancements such as digital reading platforms or multimedia integration could reveal fresh perspectives on how technology impacts the process of reading comprehension.

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Conflict of Interest

The author has no personal or financial interests that could potentially influence this work.

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AUTHOR(S) BIOSKETCHES

Reza Nejati has taught English for over 40 years. He has taught general English courses as well as language testing and research methods in applied linguistics. Among his research interests are foreign language aptitude, reading comprehension, and vocabulary development. Online instruction is also of interest to him.

Nejati, R. Associate Professor, Applied and Computational Linguistics, Shahid Rajaee Teacher Training University, Tehran, Iran

reza.nejati@sru.ac.ir

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ORIGINAL RESEARCH PAPER

The Impact of Software Pedagogy on Architectural Creativity: Finding the Appropriate Method and Time for Teaching Software to Architecture Students

S.M.A. Ahmadi Tabatabaie, S.M. Moosavi*

Department of Architecture, Faculty of Art & Architecture, University of Mazandaran, Babolsar, Iran

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[1] Corresponding author
Mohsen.moosavi@umz.ac.ir
(+98912) 5137828

ABSTRACT

Background and Objectives: The rapid advancement of computer technology has revolutionized various aspects of work and life, emphasizing the need for training and proper utilization of digital tools. Architectural software has become integral to the design process, enabling architects to explore new methods. However, concerns have arisen regarding the impact of software on creativity and innovation. This study aims to determine the appropriate timing and method for teaching software to architecture students while mitigating the negative effects on creativity. The findings will contribute to the development of more effective software training approaches in architecture schools and design firms. While technology offers benefits such as increased design speed and visualization, a balance between digital tools and traditional methods should be maintained in architectural education.

Materials and Methods: The study adopts a qualitative approach, involving activities such as observation, interviews, and extensive participation in research activities to obtain firsthand information about the research subject. Qualitative research encompasses various data collection methods such as field research, observation or participation, and in-depth interviews. In the initial phase, the documentary method and library study were employed to establish the theoretical foundations of the research topic. In-depth interviews were conducted to gather information from experts in the field of architectural education. Data analysis involved content analysis, where the components of the collected text were categorized and counted. The independent variables of the research are the correct method and timing of teaching architectural software to students, while the dependent variable is the improvement of students' efficiency and benefit from learning the software. The findings were derived from the analysis of the interview responses and logical reasoning.

Findings: The findings of the research indicate that students entering the field of architecture should first develop a solid foundation in hand drawing and design principles before delving into architectural software. Early exposure to software without a proper understanding of architecture can hinder creativity and result in the production of complex forms devoid of purpose and spatial understanding. It is recommended that students establish a strong connection between their hand, eye, and mind through freehand drawing and creative thinking before transitioning to digital software. The concept stage of design is best approached through manual sketches and modeling, while software can be utilized in later stages. Simultaneous teaching of software alongside other architectural subjects may lead to information overload and reduced focus. A progressive and integrated approach to teaching software within the curriculum is suggested to enhance students' practical application of software tools. This research provides insights for developing an effective educational method that prepares students for the job market while fostering their creativity and architectural understanding.

Conclusions: The research findings suggest that students should learn architectural software after developing a foundation in hand drawing and design principles. Starting software training too early can hinder creativity and result in superficial designs. Teaching software alongside other architectural subjects in a progressive and integrated manner is recommended. Practical, project-based training helps students understand software features and promotes lasting learning. Unnecessary software components should be avoided to prevent confusion. Universities should modify their programs to meet students' needs in the job market and provide comprehensive software education.

NUMBER OF REFERENCES
66

NUMBER OF FIGURES
5

NUMBER OF TABLES
5

مقاله پژوهشی

تاثیر آموزش نرم‌افزار بر خلاقیت معماری: یافتن روش و زمان مناسب برای آموزش نرم‌افزار به دانشجویان معماری

سید محمد علی احمدی طباطبایی، سید محسن موسوی*

گروه آموزشی معماری، دانشکده هنر و معماری، دانشگاه مازندران، بابلسر، ایران

چکیده

پیشینه و اهداف: پیشرفت سریع فناوری کامپیوتر، جنبه‌های مختلف کار و زندگی را متحول کرده و بر لزوم آموزش و استفاده صحیح از ابزارهای دیجیتال تاکید دارد. نرم‌افزارهای معماری به فرآیند طراحی تبدیل شده‌اند و معماران را قادر می‌سازند تا روش‌های جدید را کشف کنند. با این حال، نگرانی‌هایی در مورد تأثیر نرم‌افزار بر خلاقیت و نوآوری ایجاد شده است. این مطالعه با هدف تعیین زمان و روش مناسب برای آموزش نرم‌افزار به دانشجویان معماری ضمن کاهش اثرات منفی بر خلاقیت انجام شده است. این یافته‌ها به توسعه رویکردهای آموزش نرم‌افزار موثرتر در دانشکده‌های معماری و شرکت‌های طراحی کمک خواهد کرد. در حالی که فناوری مزایایی مانند افزایش سرعت طراحی و تجسم را ارائه می‌دهد، تعادل بین ابزارهای دیجیتال و روش‌های سنتی باید در آموزش معماری حفظ شود.

روش‌ها: این مطالعه رویکردی کیفی را اتخاذ می‌کند که شامل فعالیت‌هایی مانند مشاهده، مصاحبه و مشارکت گسترده در فعالیت‌های پژوهشی برای به دست آوردن اطلاعات دست اول در مورد موضوع تحقیق است. تحقیق کیفی شامل روش‌های مختلف گردآوری داده‌ها مانند تحقیق میدانی، مشاهده یا مشارکت و مصاحبه‌های عمیق است. در مرحله اول از روش اسنادی و مطالعه کتابخانه‌ای برای ایجاد مبانی نظری موضوع تحقیق استفاده شد. مصاحبه‌های عمیق برای جمع‌آوری اطلاعات از کارشناسان در زمینه آموزش معماری انجام شد. تجزیه و تحلیل داده‌ها شامل تحلیل محتوا بود که در آن اجزای متن جمع‌آوری شده دسته بندی و شمارش شدند. متغیر مستقل تحقیق روش و زمان بندی صحیح آموزش نرم‌افزارهای معماری به دانشجویان و متغیر وابسته ارتقای کارایی و بهره مندی دانشجویان از یادگیری نرم‌افزار می‌باشد. یافته‌ها از تجزیه و تحلیل پاسخ‌های مصاحبه و استدلال منطقی به دست آمده است.

یافته‌ها: یافته‌های پژوهش حاکی از آن است که دانشجویانی که وارد رشته معماری می‌شوند، قبل از پرداختن به نرم‌افزارهای معماری، ابتدا باید پایه‌ای محکم در اصول طراحی دستی و طراحی ایجاد کنند. استفاده زودهنگام از نرم‌افزار بدون درک صحیح از معماری می‌تواند مانع خلاقیت شود و منجر به تولید فرم‌های پیچیده عاری از هدف و درک فضایی شود. توصیه می‌شود که دانشجویان قبل از شروع به استفاده نرم‌افزار دیجیتال، از طریق طراحی دست آزاد و تفکر خلاق، ارتباط قوی بین دست، چشم و ذهن خود برقرار کنند. مرحله مفهومی طراحی به بهترین وجه از طریق طرح‌های دستی و مدل سازی انجام می‌شود؛ نرم‌افزار را می‌توان در مراحل بعدی مورد استفاده قرار داد. آموزش همزمان نرم‌افزار در کنار سایر موضوعات معماری ممکن است منجر به اضافه بار اطلاعات و کاهش تمرکز شود. یک رویکرد مترقی و یکپارچه برای آموزش نرم‌افزار در برنامه درسی برای افزایش کاربرد عملی ابزارهای نرم‌افزاری توسط دانش آموزان پیشنهاد شده است. این تحقیق بینش‌هایی را برای توسعه یک روش آموزشی مؤثر ارائه می‌دهد که دانشجویان را برای بازار کار آماده می‌کند و در عین حال خلاقیت و درک معماری آنها را تقویت می‌کند.

نتیجه‌گیری: یافته‌های تحقیق نشان می‌دهد که دانشجویان باید نرم‌افزار معماری را پس از ایجاد پایه‌ای در طراحی دستی و اصول طراحی بیاموزند. شروع زودهنگام آموزش نرم‌افزار می‌تواند مانع خلاقیت شود و منجر به طراحی‌های سطحی شود. آموزش نرم افزار در کنار سایر دروس معماری به صورت پیش رونده و یکپارچه توصیه می‌شود. آموزش عملی و مبتنی بر پروژه به دانش‌آموزان کمک می‌کند ویژگی‌های نرم‌افزار را درک کنند و یادگیری پایدار را ترویج می‌کند. برای جلوگیری از سردرگمی باید از اجزای نرم افزاری غیر ضروری اجتناب شود. دانشگاه‌ها باید برنامه‌های خود را برای رفع نیازهای دانشجویان در بازار کار اصلاح کنند و آموزش نرم‌افزاری جامع ارائه دهند.

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* نویسنده مسئول
Mohsen.moosavi@umz.ac.ir
۰۹۱۲-۵۱۳۷۸۲۸

Introduction

The rapid advancement of computer technology has revolutionized various aspects of work and life, making training and proper use of these technologies essential [1]. Digital technologies are recognized as essential tools for achieving quality, universal, and equitable education [2-4]. Today, social and technological innovations are intertwined, and the use of digital tools in the design process has become essential. Architectural software, such as computer-aided design, parametric design, 3D printing, augmented reality, and artificial intelligence, has transformed the architectural design process, enabling architects to invent new design methods. As a result, the use of these technologies has been accelerated in architecture schools and design companies [5- 7].

Moreover, the complexity of building construction projects and the need for more efficient and cost-effective manufacturing methods have made it critical to develop architectural engineering education using multimedia systems such as immersive virtual reality, videos, and simulation technologies [8,9]. Such advancements can also be particularly useful in disaster-prone areas for building shelters quickly and efficiently [10].

However, while learning architectural software is crucial for architecture students to increase the speed of work, prepare them to enter the labor market, and create designs with formal complexities, concerns have been raised regarding the impact of software on students' creativity and innovation. This study aims to determine the appropriate method and time for teaching software to architecture students to mitigate the negative impacts of using software on their creativity and innovation.

This research seeks to answer two main questions: when is the best time to start teaching architectural software to students, and what is the most effective method of teaching these software tools? The study will employ qualitative and survey methods, using content analysis to evaluate the gathered data from interviews.

The classification of digital design methods shows that the computer is not a neutral tool but actively shapes the designer's thinking and problem-solving approach [11]. Therefore, it is essential to determine the appropriate way and time to teach software to architecture students to ensure that their creativity and innovation are not limited to software. This study aims to provide insights into the best practices for teaching software to architecture students, taking into account their creativity and innovation. This research aims to find answers to the following questions: When is the best time for architecture students to start learning architectural software? And what is the best way to learn these software programs? The findings of this research will inform the development of more effective software pedagogy in architecture schools and design companies.

Review of the Related Literature

While information and communication technologies have been successful in teaching and learning, they face challenges in creative fields like architecture [12]. The range of professional skills required in architecture, including freehand design and model making, are traditionally passed down from teacher to student [13]. However, the new digital generation of students has led to a shift towards computer-aided design, which can significantly improve the quality of teaching and learning [14,15].

The use of software in the design process has received significant attention from

researchers, as it may limit creativity, which is a crucial tool for designers [16]. Architectural software, despite their high efficiency and accuracy, can be complex and confusing for students [17]. Therefore, choosing the right software and using it effectively at all levels of design is essential for maintaining creativity [18]. Juhani Palasma believes that computers are incapable of thinking and imagination, and such mental abilities cannot be digitized or simulated by computers. The involvement of computers in design diminishes the role of humans in the design process and naturally diminishes their imaginative role [19].

The use of technology has many benefits, including increased design speed and the ability to visualize architectural plans from all angles before implementation [15, 20]. Virtual Reality (VR) technology is an essential tool for transitioning from teacher-centered to student-centered learning. VR technology offers an efficient and engaging way for students to learn, and it can be easily used in many courses offered in the architecture curriculum [21-24]. Architectural professors and students have a strong preference for using architectural design software due to its high precision, aesthetic appeal, ease of modification, and time-saving benefits [15].

Moreover, the development of computational design tools, such as generative design and machine learning, has also helped architecture students achieve better results in designing complex and challenging spaces [25]. However, to maintain a balance between digital tools and traditional methods, education based on manual skills and one-to-one construction should still be a fundamental part of architectural education programs [13,26]. the current structures of architecture education curricula cannot match the innovative challenges and social demands of architecture in the digital age [27].

As observed, most research has focused on the numerous benefits of architectural software in improving architectural quality, while some have addressed the drawbacks and deficiencies in education. However, none of the studies have delved into the impact of software on creativity, which is one of the primary tools of architects. Fostering creativity among architecture students is one of the main objectives of architectural education. Despite the considerable advantages of architectural software, it is essential to evaluate the side effects on students to determine the best approach for their education.

Optimized Learning Process

The optimized learning process refers to the use of methods that help students achieve the best results in the process of architectural design, taking into account the needs of the students and the characteristics of the software [21]. To achieve this goal, attention must be paid to the needs of the students in the learning process and methods should be chosen that facilitate learning and increase the students' concentration. In addition, modern and digital tools should be used for education, so that students can become familiar with new and better methods and achieve the best results in the process of architectural design [28-31].

Design Process

The architectural design process involves stages that range from initial design to project implementation [32, 33]. In this process, the design process is optimized based on the needs of the clients [34, 35]. The design stages include problem analysis, preliminary design, detailed design, and implementation [36]. In each of these stages, the characteristics and needs of the clients are considered to reach a final design that is compatible with the clients' goals [37-40].

Concept

Concept formation is a crucial aspect of architectural design. The concept is the result of problem analysis and is created in different stages of design with different scales and hierarchical nature [41]. Concept in architecture refers to the fundamental idea or central concept behind the design and creation of a building or architectural space [42]. This conceptual framework is used by architects to generate plans, forms, structures, and architectural details [11, 31]. Concepts are expressed with a simple diagram and a few words and may include the whole project or be part of the related plan [43]. Concepts are solutions to design problems that are formed in the mind, and their ability to be implemented is higher than ideas [39, 44, 45]. The concept is defined as the answer to the question because it is a vital question in the advancement of architectural design [46]. The architectural concept serves as a guide and foundation for design and implementation decisions throughout the architectural process. The architectural concept is intertwined with concepts of spatial qualities, interaction with the environment, user experience, materials and structures, connection with social and cultural context, and technology and innovation [47].

Digital architecture

Digital architecture is a field that utilizes computer modeling, programming, simulation, and visualization to create virtual forms and physical structures [48]. This movement in architecture provides a platform for increased creation and innovation by bridging architecture and digital science [11, 49]. Digital architecture encompasses all aspects of architecture, not only in the design and planning phase but also throughout the execution or construction phase. Furthermore, it can offer aesthetics through computer devices and systems with patterns different from contemporary architecture [50]. Digital architecture refers not only to architectural designs created using digital tools but also to designs proposed by computers as design collaborators [51,52]. Digital technologies make projects more efficient. Digital architecture is not merely the adoption of a set of technologies; it represents a fundamental shift in the architectural culture worldwide [53-55]. The use of digital design tools, aided by high-speed computer processing, increases the speed of design [56]. Architectural software in Iran can be divided into two categories: software used for drawing and presenting works and software that influences the conceptualization and architectural design process [57].

Digital architecture is already functioning worldwide, particularly with the use of Building Information Modeling (BIM), and its influence and culture cannot be disregarded. Despite being a relatively young subject, it necessitates scientific research [58]. Artificial intelligence has emerged as the latest digital tool that assists architects in various aspects, ranging from designing traditional structures to creating decorative elements [59].

Research innovation

This research focuses on the innovative aspect of investigating the impact of software pedagogy on architectural creativity. While previous studies have primarily highlighted the benefits of architectural software in enhancing architectural quality and discussed the drawbacks and deficiencies in education, none have specifically addressed the influence of software on creativity, which is a fundamental tool for architects. This study aims to fill this gap in the literature by exploring the appropriate method and time for teaching software to

architecture students, taking into account the potential negative effects on their creativity and innovation.

The research seeks to provide answers to two key questions: when is the optimal time to introduce architectural software to students, and what is the most effective teaching method for these software tools? By employing qualitative and survey methods, including content analysis of interview data, the study aims to shed light on these questions.

Method

This research is practical in terms of its purpose, and the results of this research can be used to improve the time and method of teaching architectural software to students in this field. In terms of method, the present research is qualitative. Qualitative research is a set of activities such as observation, interview, and extensive participation in research activities, which help the researcher obtain first-hand information about the research subject [60-62]. The term qualitative research refers to several methods of data collection, such as field research, observation or participation, and in-depth interviews. There are considerable differences between these strategies, but all of them emphasize approaching the data [63, 64].

Participants

According to the topic, the statistical population of this research is the experts in the field of architectural education, professors working in the public universities of Tehran (University of Tehran, Shahid Beheshti University, University of Science and Technology, University of Arts, Shahid Rajaei University, Tarbiat Modares University, etc.) Ph.D. who are rich in information in the target area of research and have more than 10 years of teaching experience in architectural design courses. The purposeful sampling method was selected based on the mentioned criteria. The number of statistical population was determined by experts, and 15 of these professors were interviewed.

Instruments

In the first part, the documentary method and library study were used to verify the theoretical foundations of the research topic. To collect information, an in-depth interview method was used to clarify different angles of the problem and gather the required information. For this purpose, a researcher-made questionnaire was designed, the reliability of which was confirmed by experts.

Design

The research design is qualitative, incorporating various methods such as observation, interviews, and extensive participation in research activities. The data collection methods include field research, and in-depth interviews. Although these strategies have differences, they all emphasize approaching the data.

Procedure

Data analysis in qualitative research begins immediately after the beginning of data collection. In fact, data collection and analysis are usually done simultaneously. As the research continues, less data is collected, but more analysis is done. In practice, there is considerable overlap between these two stages. Qualitative data analysis requires information organization and data reduction [63]. To evaluate the data in this research, the method of content analysis has been used. The content analysis consists of placing the components of a text, such as words, sentences, and paragraphs in predetermined categories. The method requires the classification and counting of elements and components of content [65].

The independent variables of this research are the correct method and proper timing to teach architectural software to students. The dependent variable is increasing the efficiency and benefit of students from learning architectural software so that they are fully prepared to enter the job market. The independent variables as the cause of the relationship will affect the dependent variable as the effect.

After conducting interviews with architecture experts (university professors), their responses were classified and coded using MaxQDA 2020 software. The amount of information obtained from the interviews was reduced using coding techniques, and the points they expressed in response to the questions were analyzed in the form of logical reasoning to determine the effect of these points on the main topic of the research. These analyses are presented in the findings section. By performing these analyses and logical conclusions from the answers of the interviewees, the answers to the research questions were also determined.

The purpose of this type of research is to reach theoretical saturation or not to add a new concept to the collected concepts. In the interview method, new points that were hidden from the researcher emerged. Therefore, the researcher, as an interpretive and determining element, repeatedly refers to the identified and required sources of the research problem to reach theoretical saturation [66].

Results and Findings

In this section, the responses of the interviewees were analyzed and the findings were categorized to determine the answers to the main research questions with logical arguments.

Preparations for starting the software

When students enter the field of architecture, they do not have a correct understanding of this field and profession, they are not familiar with the concepts and basics of architecture, and they do not know design and drawings. In the first step, it is better for students to familiarize themselves with drawings, design, and the basic principles that an architect must know so that they can objectify what they have in mind and visualize it using the visual literacy and understanding they have gained from design.

The ability to design and draw by hand is one of the skills that every architect should know and use to express his meaning. Freehand design, along with the principles and basics of architecture, makes intellectual and mental creativity flourish and the power of imagination develops. After the flourishing of creativity and imagination, it is the time when the student can properly think about the subject of architecture and start developing ideas, then visualize them and draw them on paper with the ability to draw by hand. When the correct connection between the hand, eye, and brain is established and it can understand the proportions with the eye and draw the perspective; his talents flourish.

> *Architecture is a field in which the discussion of the perception of action and creativity is particularly important. In the first semester, the student gets to know the principles and basics of architecture, how to think, how to design, and how the design process takes place. It is easier and better to transfer the thoughts of the mind from hand to paper*. (Interviewee No. 2).

Disadvantages of starting the software early

When the student is not yet fully familiar with drawings and does not have a correct

understanding of architecture, if he enters the fascinating and vast world of software, he can get better results than hand drawings with little training. This issue can cause the student's heart to strengthen his hand. In the future, when he faces complex designs, he will not be able to imagine the design and will not even be able to model it. It is usually the case that people learn the software to a limited extent and leave aside the learning of the rest of the parts that have limited use in architecture. and slow down his mental capacity. Early learning causes the student to think about what he knows about the software instead of thinking freely, and his creativity decreases. In Table 1, the disadvantages of early software training are briefly stated.

The use of architectural software is an undeniable necessity, but when a student enters the world of software without understanding architecture, he can easily produce forms that are complex in terms of appearance, but because he has no understanding of the space he has created, he cannot put himself inside. imagine that space and understand the characteristics of that space and its proportions, therefore architecture is not formed and only a produced form that is not purposeful and has no idea behind it, and is not valuable in terms of architecture.

> "*Many times, after an hour of working with the software, the student produces a strange and complex form, then works on the connecting points of volumes and heights; And it changes the form and makes it more complicated. This complexity of the form increases so much that it resembles one of the works of famous architects. But basically, it is also nothing because it does not know what spatial characteristics the space it creates has. He doesn't even know what order the plan and heights are, and what issues and possibilities he produces. It only shows the capability of the software and the student's ability to work with it*." (Interviewee No. 7). (Fig. 1)

The best time to start the software

When the creative and capable mind of a student is full of innovative ideas that can provide a suitable answer to any design problem and cannot be limited by software. The best time to enter the world of software is to learn and work with it. Fig. 2 shows how effective factors for understanding the concept of architecture prepare students to enter the world of software.

When the relationship between the hand as a draftsman, the eye as an indicator to correctly understand the scale, and the mind as an idea generator is properly formed, a person can express his creativity well. Ideation with hand sketches can prevent the production of a worthless form because the person understands well what he shapes in the software and can communicate with it and solve his problems.

As shown in Fig. 2, to enter the world of digital architecture software, the student must first establish a connection between hand, eye, and mind, be able to design freely, develop his creativity, and gain the power of imagination and visualization. To achieve these abilities, it is necessary to gain the power of imagination by increasing the ability of freehand drawing and learning freehand drawing; with the help of visual literacy and the understanding he gained from architecture, he established a relationship between hand, eye, and mind and his creative power and imagination blossomed (Fig. 3 and Table 2).

Table 1: Coding the results of the early start of using software for architecture students

Code	concepts	Subcategories	Categories
Using a computer has a better graphical display than a free hand - not doing things with the hand and the power of the mind	Discouragement of freehand drawing	Decreased imagination	Inability to design
Lack of complete training - confusion in a large number of software - rely on little knowledge	Lack of learning of all parts of the software	Limiting creativity	
Creating a complex plan with limited training - not knowing the volumes in a tangible and objective way - being limited to software	Decreased power to enliven the imagination		
Lack of understanding of proportions - Lack of understanding of scale with the eyes - Lack of perspective - Inability to visualize space in three dimensions	Lack of understanding of space	Lack of understanding of architecture	

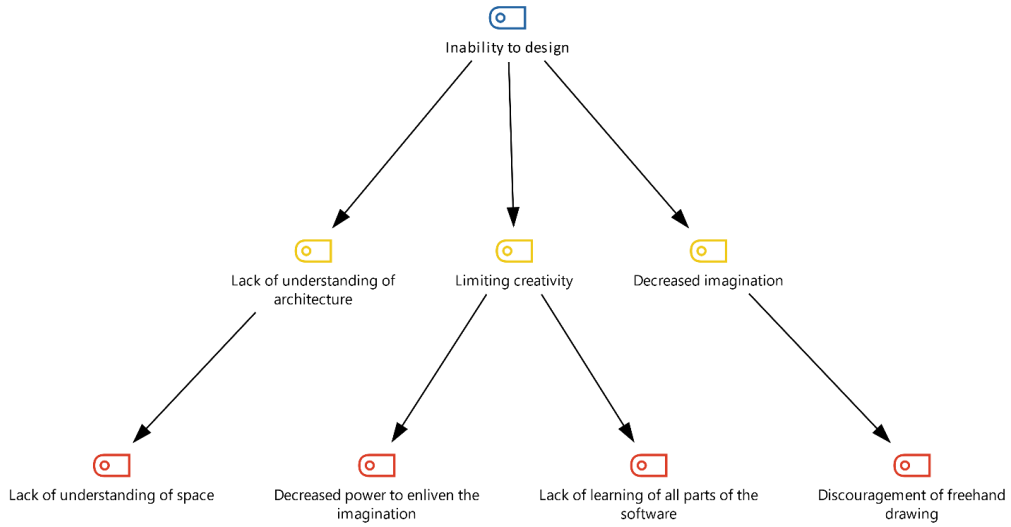

Fig. 1: Early Introduction of Software for Architecture Students Chart

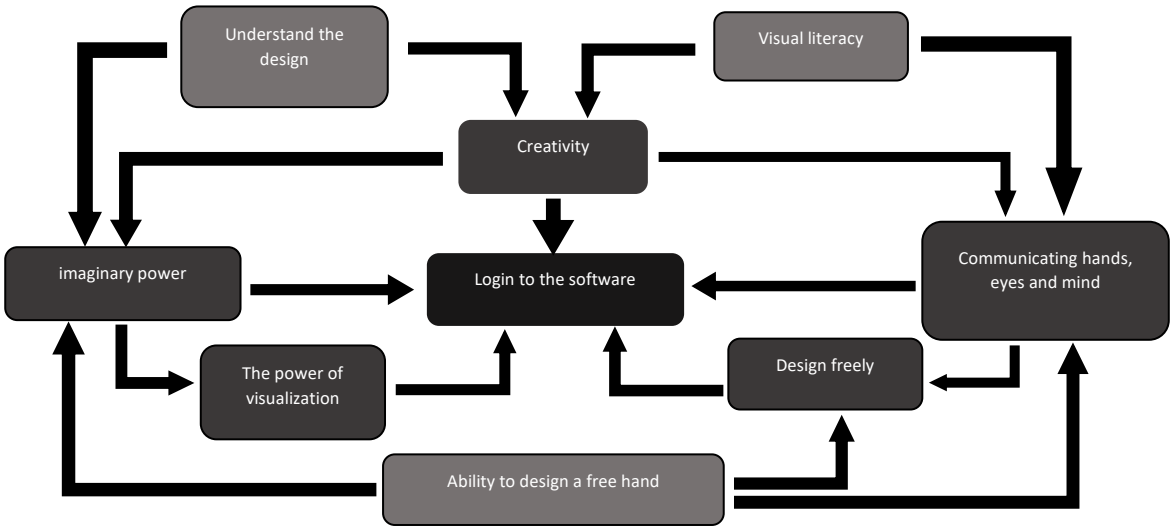

Fig. 2: Prerequisites for Software Entry for Architecture Students Chart (authors)

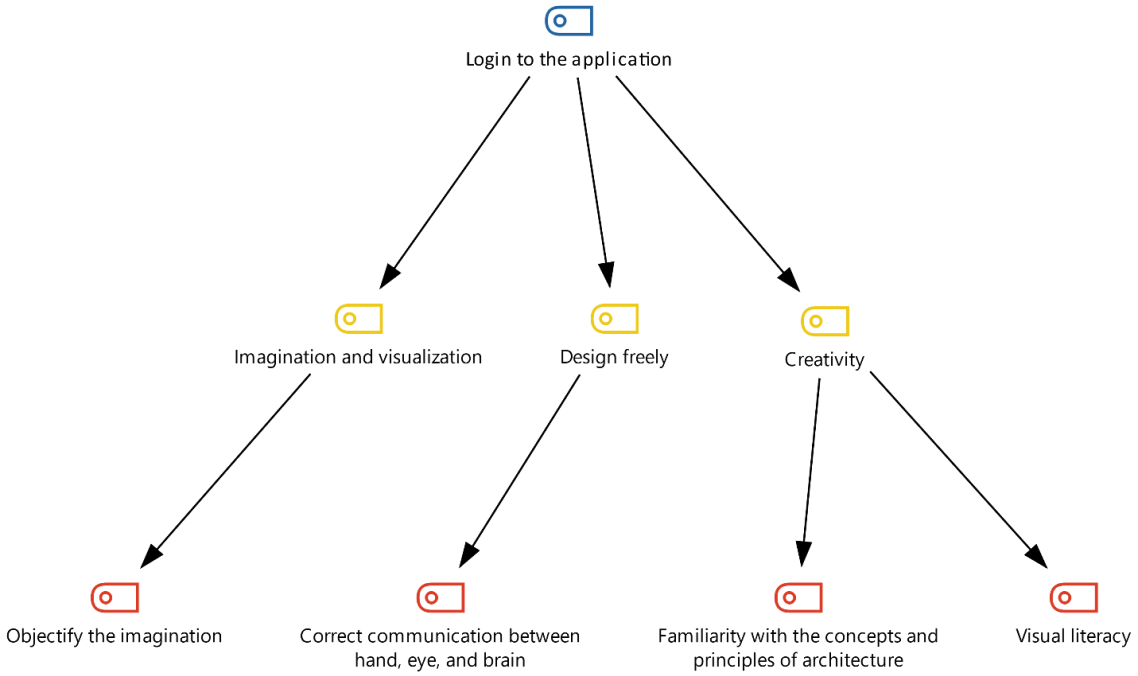

Fig. 3: Software Entry for Architecture Students Chart

Table 2: Software entry coding for architecture students

Code	concepts	Subcategories	Categories
Knowledge of architecture - Knowledge of art - Familiarity with works of art	Visual literacy	Creativity	Login to the application
Understanding Design - Understanding Proportions and Perspectives	Familiarity with the concepts and principles of architecture		
Freehand drawing - Cognition of design - Perception of perspective - Perception of proportions - Perception of dimensions	Correct communication between hand, eye, and brain	Design freely	
Ability to draw a free hand - Understand the concept of space - Strong three-dimensional thinking - Model making	Objectify the imagination	Imagination and visualization	

Computer design, a new style of design

Modeling and manual sketches are easier and more efficient at the beginning of work and in the ideation and concept stage and play an important role in the emergence of creativity. For this purpose, it is suggested to do it in the traditional way (working by hand) in the concept stage. When the concept enters the software, changes are made to it, but the main idea is preserved. And in the rest of the design stages, software can replace manual work.

> *"At the beginning of the work, I suggest students do the work manually so that their hand strength is preserved; And after the idea is formed, software should be used for presentation.* (Interviewee No. 3).

Designing with software is a new way of designing and concepts such as building information models (BIM) and virtual reality technology (VR) are based on software and computer power.

Another way to teach software

In the interviews, the professors talked about teaching the software simultaneously or separately to the students. They listed the advantages and disadvantages of these methods, which are summarized in Table 5. The professors described these points according to their experiences in teaching.

In the experience of simultaneous teaching, due to the high volume of materials and exercises and the pressure on the student, it reduces the student's learning; And it diverts their focus from the main lesson. (Interviewee No. 2).

If we can introduce and teach software related to it in every lesson, or at least encourage the student to learn them, it will help for lessons such as analysis of environmental conditions and statics, which the student will learn in a practical way and use them in his projects. use. Teaching at the same time leads to the teaching of more application software to students. (Interviewee No. 7). (Tables 3-4 & Figs. 4-5)

Table 3: Coding of simultaneous teaching of software and courses to architecture students

Code	concepts	Subcategories	Categories
Familiarity with the software related to the course - attractiveness and enhancing learning	Creating questions and motivating the student	Complete learning of software in a practical way	Software training related to each course at the same time
Apply training	Comprehensive software review		
Unnecessary learning is prevented	Training optimization	Learn more software	
Increase classroom activity	Compactness and heaviness of exercises	Damage to the course of lessons	
Need to increase teaching hours	lack of time		

Table 4: Encoding of Separate Teaching of Software and Course Units for Architecture Students

Code	concepts	Subcategories	Categories
Emphasis on software training individually	Increased focus	Complete and specialized training	Teaching software to students in a separate unit
There is enough time to teach	Complete software training		
Lack of familiarity of professors of other units with software training - training only through specialized personnel	Specialization of Education		

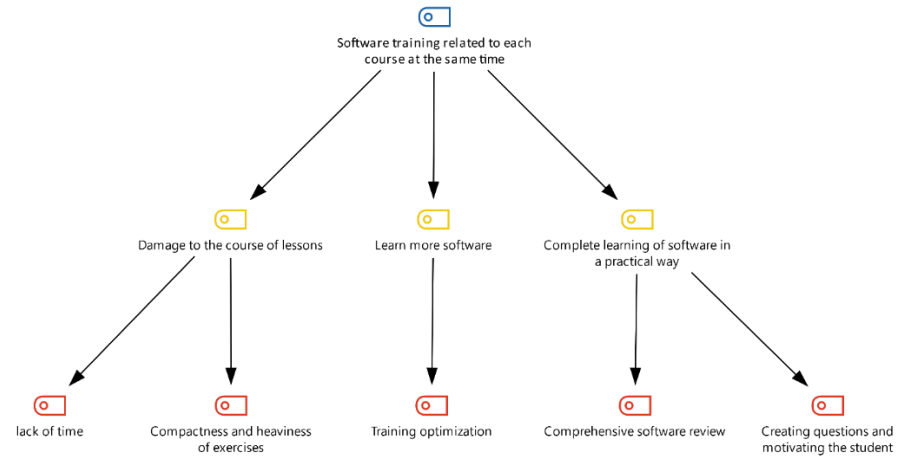

Fig. 4: Simultaneous Teaching of Software and Course Units for Architecture Students Chart

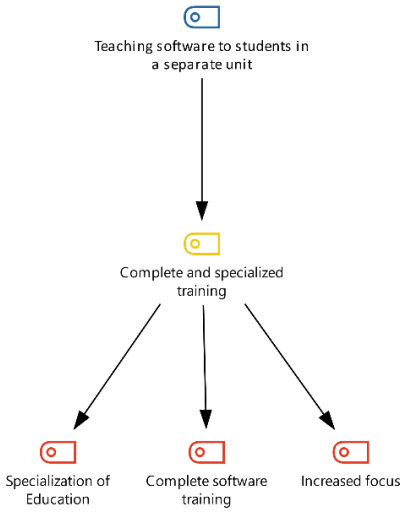

Fig. 5: Separate Teaching of Software and Course Units for Architecture Students Chart

Table 5: Pros and Cons of Separate and Simultaneous Teaching of Software and Course Units for Architecture Students

Title	Advantages	Disadvantages
Teaching related software at the same time as teaching courses	Familiarity with the correct use of software tools. Creating questions and motivating the student. Apply the tutorials. They get acquainted with the software while working. Charm and enhance learning. Unnecessary learning is prevented. Targeted training of more software.	Spend more time on lessons Damage to the course of lessons Compactness and heaviness of exercises
Teaching software as a separate course	Students focus on the topic of the lesson. Focusing on software training prevents the allocation of other training time to the software.	Failure to provide exercises appropriate to the lessons Lack of familiarity with other professors of software courses Teaching by people who do not have an architecture degree Teaching may be unrelated

To use a new method for teaching architectural software in an academic way, an educational process must first be defined and then implemented. Possible defects can be solved and compared with other methods. After understanding the advantages and disadvantages of different methods, the best possible method for education can be found. In this research, the experiences of professors about different methods of education to find a better method that makes education attractive and can prepare students for the job market and eliminate the need for classes outside the university led to the proposal of this method for education.

Discussion

According to the opinion of Juhani Palasma, computer-aided design causes the designer's imagination to diminish [19]. Our findings confirm this issue regarding students who are learning the basic principles of design. During this period, if a student relies heavily on software, their imagination declines. In researching the application of technology in the process of architectural design, Mozaffar and Khakzand stated that computers have increased the skill of architects in the process of drawing diagrams and sketches and increased the speed in all parts of drawing; and it is not recommended to teach architectural software from the beginning of the students' entry, but it is a requirement that they should be familiar with the software from one stage onwards [16]. Our findings confirm and confirm their opinions; but in another part of this research, they state that the most important tool of the designer is his creativity, which the software solidifies from the designer; but our findings show that if the student (designer) learns to show his creativity completely without the software, the software can no longer be an obstacle to creativity. Also, in the research of analyzing the effect of using digital software on the promotion of creativity in architectural design education, Asefi and Imani state that software should play a role in all levels of architecture in order to bring out creativity [18]; which agrees with the findings of this research.

The findings of the research show that, in general, it is better to use manual sketches in the idea generation stage and to refer to software only to present the work; In researching the effect of architectural design software on design speed, Shahbazi and Arbaban Esfahani showed that software increases design speed, but designers prefer manual work and sketches in the early stages of design [20]. According to Kara, manual skills such as freehand drawing and model making should be part of the architectural education program [26]. Our findings confirm this issue. Manual skills foster students' imagination.

Conclusions

The research findings provide valuable insights into the optimal timing and effective methods for teaching architectural software to students in the field. One of the key contributions of this study is the exploration of the impact of software pedagogy on architectural creativity. In the current landscape, students often face confusion in selecting the right software and appropriate educational approaches due to the abundance of available software options and new design methods. By analyzing qualitative data from interviews and conducting in-depth studies, the research sheds light on the appropriate method and time for teaching software to architecture students, with a specific focus on its influence on students' creativity.

The answer to the first question (when to start teaching software to students?) is as

follows: software training should start only when the student has learned the alphabet of architecture, his creativity has blossomed, and he knows how to design and draw by hand. With his visual literacy and understanding of architecture, he can easily objectify what he has in mind and in a word, he knows architecture; if this issue is not followed properly, it will create restrictions for the student and destroy his creativity. Therefore, the teaching of architectural software should commence in the fifth term, concurrently with Architectural Design 2, at the undergraduate level. Initially, students should be taught 2D design software, gradually progressing to advanced and 3D design stages. It is also important to note that software should not be used during the ideation phase of design to allow students' creativity to fully flourish. Afterward, the software can be utilized during the completion and editing stages of the drawings.

Nowadays, designing with software has become the main way of designing in architectural offices, and it is almost impossible to design without the help of computers. But if the student enters this field directly into the software, he cannot develop his mental skills as an architect (the one who creates the space). Someone who has learned to design with the software but does not have the skills to understand three-dimensional space is more like a sculptor who designs a good volume but cannot understand its dimensions, know the sense of space and the impact of this volume on the surrounding environment. to understand. The result of this architecture is a break from the design context. An architect must see all aspects of work in design before construction, and if he cannot cultivate this power in himself and only relies on software, he will face problems in the future.

Also, in response to the second question of the research (how to effectively teach architectural software to students?), it can be concluded that; The advantages of teaching related software at the same time as teaching lessons are more than its disadvantages; And it can better attract students to education and help them achieve their goals. In order to learn a software, we must first know the goal of the software producer and know their outputs, and move the learning path towards the best outputs. It is better to start the training with simpler software and enter specialized plugins in the later stages. Also, practical training for students should be in such a way that they can work with the software in a principled and scientific way and solve their needs. This project-based education, considering the attraction it creates for students, can play a significant role in discovering the features of the software and better and more lasting learning. Teaching parts of the software that are not necessary for the students of this field should be avoided because it only confuses them.

If the environment of the university and the educational program of the university can meet the needs of students to enter the labor market, then the education has been correct. For various reasons, software education, which is called the new way of designing today, is scarce in universities. In order to enter the labor market, a student needs to know and work with software. Unfortunately, after entering the labor market, the student faces a lot of software and different educational methods, which has nothing but confusion for him. The university can effectively prepare people for the job market and give them correct and complete education by modifying its educational program and changing the course of the semester.

In the next step, the teaching methods should be investigated by conducting quantitative studies in order to determine their effectiveness and determine the best way to teach software to the students of this field.

Authors' Contribution

Seyed Mohammad Ali Ahmadi Tabatabaie was involved in the sections of study design, literature review, data collection, analysis and interpretation of results, writing the original version, and editing the article in this research. Seyed Mohsen Moosavi was engaged in the sections of study design, literature review, article editing, manuscript correction, and article review in this research.

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Conflict of Interest

The authors have no conflicts of interest.

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AUTHOR(S) BIOSKETCHES

Seyed Mohammad Ali Ahmadi Tabatabaie is a master's holder of Mazandaran University. His the main research field of interest are Architectural Pedagogy, Architectural Design Process, Sustainable Architecture, and Residential Spaces.

Ahmadi Tabatabaie, S.M.A. Senior Expert, Architecture, Mazandaran University, Babolsar, Iran
alitabatabaie.076@gmail.com

Seyed Mohsen Moosavi is faculty member of Department of Architecture at the University of Mazandaran. His main research field of interest are Architectural Pedagogy, Architectural Design Process and Sustainable Architecture.

Moosavi, S.M. A/Professor, Architecture, University of Mazandaran, Babolsar, Iran
Mohsen.moosavi@umz.ac.ir

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ORIGINAL RESEARCH PAPER

Learners' growth mindset: Can bichronous gamified/interactive content make a difference?

***Z. Saeedi*[*,1], *N. Nikoobin Boroojeni*[2]**

[1] *Department of English Language, Persian Literature and Foreign Languages, Allameh Tabataba'i University, Tehran, Iran*

[2] *Department of Foreign Languages, Kharazmi University, Tehran, Iran*

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* Corresponding author
Saeedi.za@atu.ac.ir
Saeediz240@yahoo.com
(+98912) 212 35 21

ABSTRACT

Background and Objectives: Educational psychology is one of the core concepts in the area of teaching and learning and plays a key role in any educational context including language instruction. Learners' mindset (fixed or growth) may have an impact on the learning process and the ubiquitous technology can be of influence in making a change in students' mindset. Despite the claim that through practice learners can improve in their subjects, many still consider it futile without related innate intelligence. Finding solutions for shifting this detrimental mindset is essential. Therefore, this study aimed to clarify the effect of using gamified and interactive content (H5P) on shifting English learners' mindset, moving from a fixed mindset into a growth one. Another purpose was to discover the probable relationship between learners' different General English (GE) levels, the rate of their initial mindset, and the proportion of change induced in their mindset throughout the course.

Materials and Methods: The participants consisted of 225 students aged 12-13 (111: experimental; 114: control). After conducting a placement test and using Dweck's (2017) mindset questionnaire to measure their initial mindset, both groups went through a 12-week-long course, receiving similar instruction, except for the teaching phase. While the experimental group's course was conducted through gamified and interactive content hosted on the Learning Management System, the control group's was conducted live through web conferencing. Afterward, the learners redid the questionnaire. Data analysis was performed using ANCOVA and ANOVA statistical tests.

Findings: To compare the GE levels two by two, a Scheffe test was used, and based on its results, it can be deduced that mindset differences mean for Pre-A1 ($p = 0.001$), A1 ($p = 0.001$) and A2 and above ($p = 0.025$) were all significant. Comparing the mindset differences means between the three English level groups, it can be inferred, however, that the Pre-A1 group was the highest in mindset differences mean, while A2 was the lowest. In other words, the weaker was the students' level of GE, the higher the amount of change in their mindset type towards a growth one. The findings of the present study showed that the use of gamified interactive content (H5P) in the bichronous format of the LMS can have a significant effect on improving high school EFL learners' Growth Mindset levels by 39%. The contents, which were provided for students in both gamified and H5P classes, resulted in immediate feedback exchanges, which raised the motivational level and encouraged them to go on with different interactive tasks and activities.

Conclusions: After carrying out the research, the researchers concluded that using gamified and interactive content as part of the learning process could induce a Growth Mindset in learners, higher GE students mostly had higher initial rates of Growth Mindset, and weaker learners experienced greater shifts towards growth. This study can motivate language learners and teachers to utilize gamified and interactive content in online courses and can help educational system policymakers notice more deeply the effect the application of gamification and H5P plugins have on teaching English, which can result in new curriculum development for schools.

NUMBER OF REFERENCES	NUMBER OF FIGURES	NUMBER OF TABLES
43	3	9

مقاله پژوهشی

ذهنیت رشد زبان‌آموزان: آیا محتوای ترکیبی بازی‌گونه/تعاملی می‌تواند تفاوت ایجاد کند؟

زری سعیدی*[1]، نیلوفر نیکوبین بروجنی[2]

[1] گروه آموزش زبان انگلیسی (زبانشناسی کاربردی)، دانشکده ادبیات فارسی و زبان‌های خارجی، دانشگاه علامه طباطبایی، تهران، ایران

[2] گروه آموزش زبان انگلیسی، دانشکده ادبیات فارسی و زبان‌های خارجی، دانشگاه علامه طباطبایی، تهران، ایران

چکیده

پیشینه و اهداف: روانشناسی آموزشی یکی از مفاهیم اساسی در حیطه تدریس و یادگیری است و نقشی کلیدی در هر بافت آموزشی از جمله آموزش زبان ایفا می کند. ذهنیت (چه ذهنیت رشد و یا ثابت) فراگیران ممکن است روی فرایند یادگیری تاثیرگذار باشد و فناوری با قابلیت حضور همه جائی خود احتمالا بتواند در ذهنیت دانش آموزان تغییر ایجاد کند. علیرغم این دعوی که فراگیران از طریق تمرین میتوانند در دروس خود پیشرفت کنند، بسیاری هنوز این امر را بدون داشتن هوش ذاتی بی فایده می شمارند. یافتن راه حلی برای تغییر چنین چارچوب ذهنی ضروری است، کاری که امکانات انگیزه بخش فناوری برای انجام آن مفید به نظر می رسد. به همین جهت هدف این مطالعه شفافسازی تأثیر استفاده از محتوای بازی گونه شدگی و تعاملی (H5P) در تغییر چارچوب ذهنی فراگیران نسبت به یادگیری به چارچوب ذهنی رشدی است. همچنین، هدف دیگر آن کشف ارتباط بین سطوح مختلف زبان عمومی فراگیران و نوع چارچوب ذهنی اولیه آن‌ها و میزان آن، و مقدار تغییرات ایجاد شده در چارچوب ذهنیشان در طول دوره است.

روش‌ها: این پژوهش طرح نیمه آزمایشی پیش آزمون/پس آزمون دارای گروه کنترل است. شرکت‌کنندگان شامل ۲۲۵ دانش آموز ۱۲-۱۳ ساله دوره اول دبیرستان (۱۱۱: گروه آزمایش ؛ ۱۱۴: گروه کنترل) بودند. پس از انجام آزمون فلایرز کمبریج برای شناسایی سطح مهارت انگلیسی آن‌ها، از پرسشنامه ذهنیت دوئک برای اندازه گیری نوع و میزان اولیه چارچوب ذهنی آن‌ها استفاده شد. متعاقباً، هر دو گروه دوره ۱۲ هفته‌ای را گذراندند و طی آن از هر لحاظ، به جز یک مورد، تدریس مشابهی را دریافت کردند. هر دو گروه از حالت همزمان سیستم مدیریت یادگیری برای تمرین کاربردهای زبان و از حالت ناهمزمان آن برای آزمون دادن و ارسال تکالیف خود استفاده کردند. تنها تفاوت در این بود که مرحله آموزش گروه آزمایش از طریق محتوای تعاملی در حالت ناهمزمان سیستم مدیریت یادگیری انجام گرفت، اما آموزش گروه کنترل به صورت زنده و با استفاده از تقریباً همان مطالب، از طریق وبینار انجام شد. پس از گذراندن دوره، فراگیران مجدداً پرسشنامه را تکمیل کردند. تحلیل آماری از طریق آزمون‌های تحلیل واریانس (آنووا) و تحلیل کوواریانس (آنکووا) انجام شد.

یافته‌ها: به منظور مقایسه سطوح انگلیسی عمومی (GE) بصورت دو به دو، از آزمون شفه (Scheffe test) استفاده شد. بر اساس نتایج آن، می‌توان استنباط نمود که ضریب تفاوت میانگین‌های ذهنیت برای سه سطح زبانی، ماقبل پیشرفته (Pre-A1) (p=۰/۰۰۱)، سطح پیشرفته ۱ (p=۰/۰۰۱)، و سطح پیشرفته ۲ (p=۰/۰۲۱) بود که همگی از جهت آماری معنادار بودند. با مقایسه میانگین‌های تفاوت‌های ذهنیت بین سه گروه و سطح زبان انگلیسی، می‌توان به این نتیجه رسید که گروه ماقبل پیشرفته، بالاترین میانگین تفاوت‌های ذهنیت را به خود اختصاص داد در حالی که سطح پیشرفت ۲ (A2) دارای کمترین ضریب تفاوت بود. به عبارت دیگر، هر چه سطح انگلیسی عمومی (GE) دانش آموزان ضعیف تر بود، میزان تغییر در نوع ذهنیت آن ها به سمت شکل‌گیری ذهنیت رشد بیشتر می شد. یافته‌های مطالعه حاضر نشان داد که استفاده از محتوای تعاملی (H5P) و بازی گونه (Gamified) در قالب سامانه مدیریت یادگیری دوزمانه (Bichronous LMS) می‌تولند تأثیر قابل‌توجهی بر بهبود سطح ذهنیت رشد زبان‌آموزان دوره دبیرستان (۳۹٪) داشته باشد. مطالب و محتوائی که برای دانش‌آموزان در کلاس‌های بازی گونه یا بازی واره شده و تعاملی ارائه می‌شد، منجر به تبادل بازخورد فوری گردید که سطح انگیزه را بالا برد و آنها را تشویق نمود به وظایف و فعالیت‌های تعاملی مختلف ادامه دهند.

نتیجه‌گیری: پژوهشگران به این نتیجه رسیدند که استفاده از محتوای تعاملی به عنوان بخشی از فرایند یادگیری می تواند باعث ایجاد چارچوب ذهنی رشدی در فراگیران شود. دانش آموزان با مهارت انگلیسی عمومی بالاتر، میزان چارچوب ذهنی رشدی اولیه بالاتری داشتند، فراگیران ضعیف تر، میزان تغییر بیشتری را در چارچوب ذهنی خود از حالت ثابت به رشدی تجربه کردند. مطالعه حاضر می تواند زبان آموزان و معلمان را به استفاده از محتوای تعاملی و بازی گونه شده در دوره‌های آنلاین خود ترغیب کنند. همچنین به سیاستگذاران نظام آموزشی کمک می کند تا به تاثیری که کاربرد افزونه محتوای تعاملی و بازی گونه بر آموزش انگلیسی دارد توجه عمیق تری نمایند، زیرا این امرقابلیت آن را دارد که منجر به ایجاد برنامه درسی جدیدی برای مدارس شود.

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سامانه مدیریت یادگیری (ال. ام. اس.)

* نویسنده مسئول
Saeedi.za@atu.ac.ir
Saeediz240@yahoo.com
۰۹۱۲ -۲۱۲۳۵۲۱

Introduction

The inter-relationship between gamification and learners' conception or mindset types and the existing research gap on this issue has been accentuated in a large number of recent studies [e.g., 1, 2, 3, 4, 5, 6, 7, 8]. Game-based learning and gamified content and the way they interact with users' mindset in this new era are among the main concerns of scholars in the field of teaching and learning and that is why conducting research in this regard can play a crucial role in improving the caliber of our education system. Serving human beings for almost half a century, personal computers have, without a doubt, transformed into an almost necessity of life, and no less, education. Technology, and more specifically computer devices, has most significantly influenced the field of language education [9]. The notion of Computer-Assisted Language Learning (CALL) [10] was coined years after the invention of personal computers in the 1960s. Like CALL another terminology in the field of technology (i.e., Mobile Assisted Language Learning, MALL), became quite mainstream following the popularisation of smartphones in 2007. These tech tools have started to develop some modalities and modes of learning, which intensify the significance of carrying out more research on the relationship between the technological devices and the learners'/users' way of applying them and their conception of the potentials of these technologies.

As a matter of fact, many learners intend to add more various tech formations and use synchronous and asynchronous features of the Learning Management System (LMS) in order to learn different subjects and it is claimed by some research studies (e.g., [11-13]) that the use of technology (including gamification) can affect Learners' Mindset (either fixed or growth type). Their mindset refers to the way learners think of themselves and their learning abilities and the rate at which they relate their success or lack thereof in different areas of life to talent and intelligence or hard work.

The studies conducted on the role of LMS and technology on shifting learners' mindset, however, are rather sparse and have not focused on the effect that using asynchronous interactive content, once combined with the synchronous modality of the LMS, can have on Growth Mindset. There is still a gap on the use of gamified contents in LMS platform and the effect on the mindset of learners. There are also some research studies which have yielded contradictory results on whether the asynchronous and synchronous modes of technology-mediated classes do work as expected. This necessitates carrying out some novel studies on the inter-relationship between gamified content development and learners' mindset. Furthermore, whether students with different levels of proficiency in English are different or similar in the types of their mindset towards learning and how resilient they are in changing it are factors that require careful exploration in research. To address this need, this study aimed to explore how self-conducted use of gamified interactive content (H5P) for learning in the bichronous (a blend of both synchronous and asynchronous) format of the LMS may contribute to a significant effect (if any) on improving high school EFL learners' Growth Mindset levels. The major purpose was to investigate whether there existed any relationship between different levels of General English (GE) and the rate of change induced on their Growth Mindset levels when using gamified and interactive content, as well as with students' initial mindset levels.

Review of the Related Literature

Theoretical Foundation of Self-Determination Theory

The psychological state of human beings can have a direct effect on their behavior and activities. One of the macro theories that has dealt with this core concept is Self-Determination Theory (SDT) [14]. According to SDT, some motives (competence, autonomy, relatedness) are needed to drive the individuals and motivate them. This theory is indeed linked to the autonomous motivational dimensions of learning. It is based on the idea that by doing an activity we gain some values. Based on the tenets of SDT, it can be concluded that gamified activities and the mindset of the learners may have some potentials to boost their autonomous motivation and provide a higher level of involvement and interaction in the learning process, depending on the mode of technology or the content type developed, which are elaborated on, in the following section.

Synchronous and Asynchronous Modes of Technology

Initiated in the 1960s and defined as "any process in which a learner uses a computer and, as a result, improves his or her language" [15, p.7], CALL started to show its true potential during the 2010s with the increasing availability of the internet and technological devices such as laptops and smartphones. Following in its tracks was the growing use of Learning Management System (LMS) known as the software designed for administration of learning [16], as well as web conferencing which were applications or websites that have features such as live file and media sharing, mark up tools, hand raising, etc. used for collaboration and interaction [17].

A gamified form of content can be presented through different modes of technology one of which is LMS. Currently, it is a highlight of using technology for teaching and learning and can be used in different forms: synchronous, asynchronous or a blend of both, that is bichronous [18]. Synchronous e-learning, defined by Hyder et al., is "live, real-time (and usually scheduled), facilitated instruction and learning-oriented interaction" [17, p. 9] that is done online. Synchronous use of the LMS for pedagogical reasons usually involves employing web conferencing plugins (e.g., BigBlueButton and Adobe Connect). Asynchronous e-learning, on the other hand, is an online "self-paced learning, which students access intermittently on demand" and is usually available any time. It is "recorded or pre-produced" and can be individual, or "intermittently collaborative" [17, pp. 1-2]. Asynchronous use of the LMS for teaching involves activities such as making announcements, sharing the syllabus as well as files and media (e.g., videos, pictures, PDF, and PowerPoint files), interacting with other members of the class through forums and messaging, etc. Many of these features are available in web conferencing as well, but the main difference is that the latter occurs in real-time, while the former can be accessed at any given time (as long as the course is available). The Covid-19 widespread saw to a more common use of both synchronous and synchronous modalities of the LMS by students and teachers. The synchronous features are generally used through web conferencing plugins on the LMS, while the asynchronous features take place on the LMS itself, in the form of announcements, lessons, uploaded materials, etc. and more recently, through added gamification and interactive content (H5P) plugins.

Gamification

An important feature of the asynchronous format of the LMS is gamification, which was first defined by Brett Terill [19]. As accentuated in a number of studies [20, 21], gamification can provide the base for having more interactive classroom environment for the students and having a higher level of their engagement in learning tasks and activities. Following the socio-cultural theories of learning, it can be claimed that in gamified activities and group learning, the nature of acquisition process is changed and the cognitive-affective involvement of the learners is fostered. Recently, the students' level of social activities has decreased to a great extent due to the emergence of the new tech tools and the ubiquitous form of technology. This necessitates the application of some platforms and game-based learning so that their participation in social classroom activities is boosted and they are helped to step out of their comfort zone, being more engaged in language learning contexts. Gamification (as cited in [22]) has been defined as, "taking game mechanics and applying them to other web properties to increase engagement" [p. 18] and refers to using the properties of game design in contexts that are essentially non-game based [23].

Many gamification plugins became mainstream in course building on LMSs, the most prominent of which were progress bars, levels, leader boards, and trophies. One such plugin, used on the LMS Moodle, is LevelUp! which has two prominent features: a. each user levels up as they use the designed content and b. they can compete against other users with a feature called Ladder, essentially a leader board. Completing different activities and going through lessons adds to the users' points which add up and when enough, level them up. The Progress Bar, usually named so in different LMSs, allows the users to see how far they have come and give them a sense of achievement. The gamification plugins became popular since they allowed for a better experience and further motivation for users. Therefore, some LMS content creators began using them in accompaniment with another interesting plugin called H5P.

HTML5 Package

In spite of the many common features between asynchronous and synchronous modalities of the LMS, there are some functionalities exclusive to asynchronous e-learning. A rather new feature of the LMS not available in web conferencing is HTML 5 Package (H5P). Initially released in 2013, H5P provided web learning with an asynchronous, yet interactive format, of commonly used content such as videos, presentations and quizzes. An H5P is "a free and open-source content collaboration framework based on JavaScript… [which] aims to make it easy for everyone to create, share and reuse interactive content" ("H5P", 2020, para.1). Simply put, H5P is an LMS plugin that allows creating interactive content, each provided for a different function. The immediate feedback that such content provides the students with is believed to motivate and encourage them in learning [24]. Furthermore, they allow the learners to learn on their own and receive proper feedback without the required presence of a teacher figure.

The interactive feature of the aforementioned contents allowed the creators to give constant feedback to users without being present all the time. In other words, H5P content was programmed in a way to interact with users based on their response to the questions, tasks, etc. Such content, by nature, provided the users with a gamified experience due to its motivational affordances such as the trial-and-error format, counting the points gained, giving positive feedback to the users,

showing them their progress, and providing them with challenges to overcome [25]. The use of gamification plugins, H5P content, and other synchronous and asynchronous technological tools provided the learners with new learning prospects and shifted learning to some point.

Gamification, H5P, and Learning

The aforementioned technological tools and their improvements provided opportunities for the learners to use technology for learning better [27-28] through both synchronous and asynchronous features of the LMS. Using gamification, language learning courses are usually designed, using gamified and H5P content features, such as dictation, interactive slides, interactive quizzes, flashcards, and mini-games such as crossword puzzles, and drag-and-drop matching games; made available on both mobile phone and desktop. Due to such classes' motivational affordances, both intrinsic and extrinsic, and the fact that such classes seem to invoke in the users a set of psychological changes similar to those invoked by games, the use of H5P content and gamification is believed by many to bring about positive psychological and behavioural changes [25] [29-30]. A psychological concept that could be influenced is learners' Growth Mindset, a concept many have worked on since Dweck's [31] initial development of the term in 2006 [31-37].

Learners' Mindset

This unconscious view that the learners hold towards intelligence and talent includes growth and fixed mindsets. Learners with a Growth Mindset believe that intelligence and abilities are not fixed and inherent, but they merely require time and practice to be mastered. On the other hand, learners with a Fixed Mindset generally believe themselves to be incapable of change and progress no matter how hard they try or simply think they do not have the required skills and intelligence [38-39].

Having a fixed mindset towards learning can cause many problems for the learners, the least of which is being unsuccessful in (at least part of) their education. Many learners believe that they simply do not have the required talent for learning English and thus refuse to even try to learn. Changing this mindset, therefore, is of great importance. The attractive features of the asynchronous format of the LMS are a source of motivation and their self-conducted tasks which allow trial and error in a gamified format without consequences can bring comfort to students while learning.

When students with a fixed mindset face too many failures, they fixatedly believe that they are incompetent and resign, admitting defeat. This state of mind known as Learned Helplessness [40] needs to be dealt with in order for those learners certain of their failure, defeat and inability to begin shifting to a Growth Mindset. Those with a Growth Mindset believe intelligence and talent to be everchanging and growable, and see effort and hard work as the right track to do so. Their ultimate goal is to learn and grow, however difficult the means; therefore, challenges are desirable to them, since they see new challenges as a means of growth and development. They perceive failure as natural and a part of their journey to grow since they believe they can learn from it [31- 38].

The present study aimed to clarify whether using gamified and interactive (H5P) content can affect learners' mindset towards learning English and whether there is a relationship between students' GE levels and the rate of change induced in this mindset as well as its initial state. The dearth of research studies focusing on this matter led the researchers towards conducting this research. As mentioned before, the effect of using

gamification and H5P on some psychological concepts related to mindset, such as motivation, have been studied to some point, but even then the results showed inconsistency.

One study conducted by Inchamnan and Chomsuan [11] found gamification workflow, which focuses on the evaluation processes, and Growth Mindset positively related, however the bulk of research studies conducted regarding gamification and psychological outcomes which have yielded both positive and negative results asked for further research in this regard, thus the need for undertaking the current study arose.

Therefore, the current study intends to clarify this matter to some extent and discover the effect (in case there is any) that using gamified and interactive content can have on inducing a Growth Mindset in learners.

Fixed mindset can be detrimental and finding solutions on how to shift such a mindset into one of learning and growth in practice is essential. There are certain studies which have been claiming that practice leads learners to improvement in certain targeted domains. There are yet certain other groups, who believe that using lessons, which have proved ineffective and not working at class, will be a waste of time in absence of innate intelligence. However, the few research studies done on this matter have yielded mixed result. Therefore, this study aimed to clarify the effect of using gamified and interactive (H5P) content on shifting learners' mindset towards learning English into a Growth Mindset and answer the following questions:

- What effect (if any) does learning partly through gamified and interactive content have on changing learners' mindset towards learning English, from a fixed to a growth one?
- What relationship (if any) is there between learners' different General English (GE) levels and the type and rate of their initial mindset?
- What relationship (if any) is there between learners' different General English (GE) levels and the proportion of change induced on their mindset throughout the course using gamified and interactive content?

Method

Participants

The sampling procedure of the research was done through random and convenience sampling. First, six schools were randomly selected from the 27 schools available in the pool of data, consisted of the schools available in district 8 of Tehran, and were then randomly assigned to either control or experimental groups. Afterwards, to pick a representative class for each school, a second round of random selection was applied to the pool of samples available in each of the schools. The schools each had four to six eighth grade classes, one of which was randomly selected (cluster sampling, indeed). The classes however were left intact and were used through convenience sampling, since due to the fact that the classes could not be altered, the participants in each class were not homogenized. The participants consisted of 225 students studying at the eighth grade of high school, aged 12-13 years old, 111 (M = 39; F = 72) of whom shaped the experimental group and the other 114 (M = 36; F = 78), the control group.

After randomly assigning classes to either control or experimental groups, the students were all given a Cambridge Flyers test as a placement measurement, in order for the researchers to identify their level of General English as pre-A1, A1, or A2 and above. The students studying in eighth grade are generally supposed to reach an A1, or hopefully an A2 by the end of their primary high school years. Based on their result in the Flyers test, the students were divided into three groups: Pre-A1

(below their grade level), A1 (at their grade level) and A2 and Above (above their grade level).

Instrumentation

The questionnaire provided for evaluating the students' mindset was a 6-point scale questionnaire ranging from Strongly Agree to Strongly Disagree, and scored respectively from 0 to 5, developed by Dweck in 2006, and was used to gather the score of the participants' mindset. There were 16 items in this questionnaire. The rationale for selection of the questionnaire was its relevance, applicability, and availability in the market.

The questions in this questionnaire focused on students' view of their intelligence (e.g., My intelligence is something about me that I can't change very much) and talent (e.g., I have a certain amount of talent, and I can't do much to change it) with some questions covering both intelligence and talent (e.g., For performing well at school, innate ability matters more than hard work). The questionnaire has got high reliability, with an estimated Cronbach's Alpha of 0.84 for fixed mindset and $\alpha = 0.72$ for growth mindset. For the 16-item variant, since each item's point ranges from 0-5, the total score of the questionnaire ranges from 0-80, with 0 showing the strongest fixed mindset and 80 the strongest growth mindset.

Materials and Content

After ascertaining the teachers' ability to work with Moodle fluidly, the instructional content, including interactive and gamified content for the eight units of seventh grade and the four new units of the eighth high school grade were created on the LMS Moodle website, collaboratively by the teachers and the occasional aid of the researchers. It's worth mentioning that ability of the teachers to work with Moodle fluidity had been checked by having them work with it tentatively and necessary tips were given to them in the meantime. The web conferencing feature, (i.e., BigBlueButton) was provided on the platform in order to allow the learners in both groups to learn through mediation of bichronous environment.

Web conferencing allowed the teacher to speak using a microphone without halt and using the webcam if desired, and share presentations (ppt), PDF files and video sessions; Furthermore, a chat section and instant polls were provided. Moreover, this synchronous modality allowed the students to raise their hand, turn on their microphones, and interact with the teacher and their classmates, therefore creating quite an interactive space.
The course, designed on Moodle, was provided for mobile phone (around 70 % of the learners used their phones), tablet, and desktop use, as can be seen in Figs 1-3.

The interactive content designed for the experimental group was placed in Tile Format to allow a better gamified experience (Fig. 2). Since, this study included students with three different linguistic proficiency levels, the interactive content was designed to afford to all the three levels.

The course was designed, using gamified and H5P content features, such as dictation (Fig. 3), interactive slides, interactive quizzes, flashcards, and minigames such as crossword puzzles, and drag-and-drop matching games; made available on both mobile phone and desktop. The gamified plugin LevelUp! as well as a progress bar was also added in order to provide a richer gamified experience (Fig. 2). Gamification was a process at the classes which let the participants to apply game's typical elements (for instance point scoring, competition with others, rules of play) and extend the elements to language learning activities. This way, the participants were involved in different kinds of teacher provided tasks.

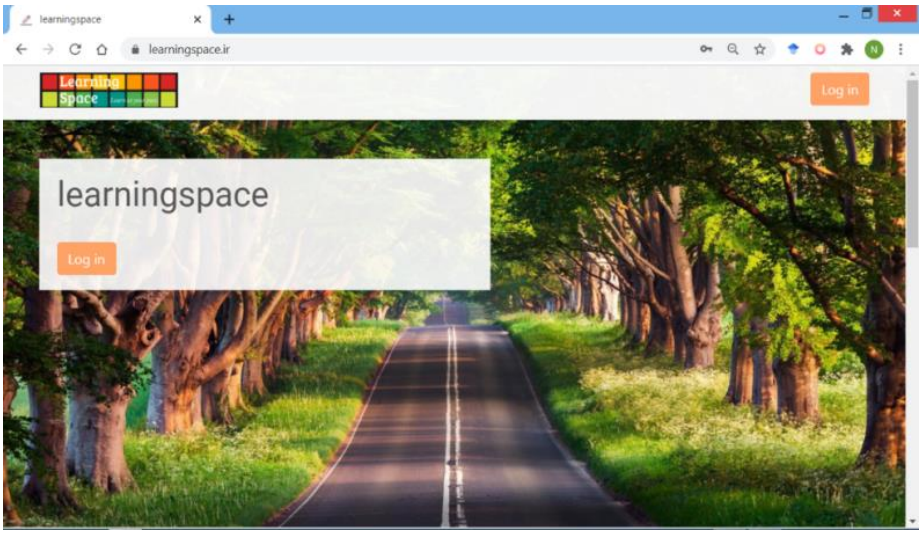

Fig. 1: Desktop/Mobile Phone Website of Moodle

Fig. 2: Interactive Lessons Designed on LMS in Tile Format and the LevelUp! Feature

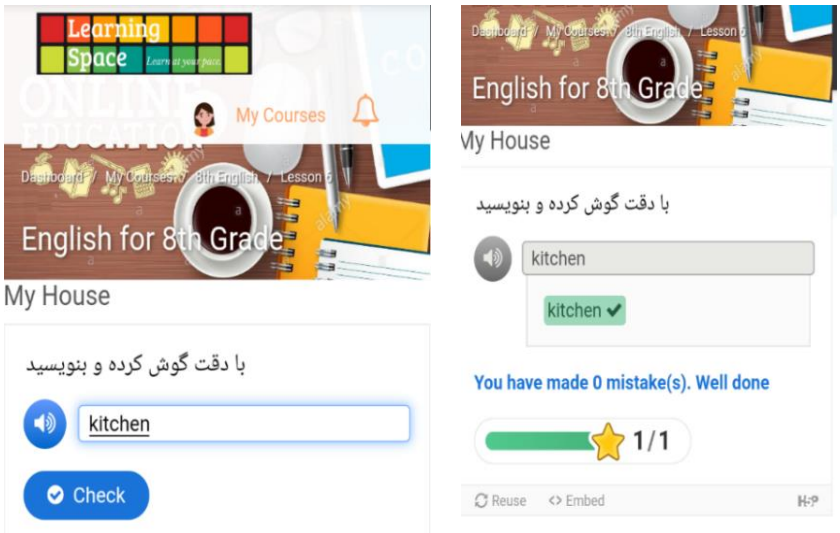

Fig. 3: Using H5P Content for Dictation

Data Collection Procedure

The students in control and experimental groups were first asked to complete Dweck's [20] mindset questionnaire on Google Forms before going through the course in order to check their initial level of mindset. They were then given the Cambridge Flyers Test, ergo identifying their level of general English as Pre-A1, A1, and A2 and Above.

The students went through the course for 12 weeks, using their designed format of instruction based on their curriculum (one lesson almost every two weeks). Both groups received similar instruction in every way, but one. They both used the synchronous modality of the LMS for practising language functions, and the asynchronous modality of the LMS (alike flipped classroom) for taking quizzes and submitting their assignments; however, the teaching phase of the experimental group was conducted through interactive content hosted on the asynchronous modality of the LMS, while the control group's was conducted, using almost the same materials (i.e., videos, PowerPoint slides, etc.), through web conferencing and in a live format.

The total instruction time for both groups was two hours for each session, with the control group using this duration to learn the lessons and practise the learned language functions and their speaking skills on the web conferencing platform BigBlueButton, and the experimental group spending an hour on BigBlueButton for practising the learned language functions and speaking, and the other hour, on using the interactive content provided on the asynchronous modality of the LMS for learning the lesson. Whether they used this time in a single sitting or throughout the week, was their decision. Gamification tasks and the course modalities were distinctive features of such classes.

Throughout the mediation course the researchers remained in touch with the teachers of all groups and received feedback on how the students were going through the course. They did not, however, intervene with the process or show the students that they were involved in this process so as not to cause a Hawthorne effect in learners. After finishing the course, the students were once again given the mindset questionnaire and their responses and mindset rate were compared.

Data Analysis

Since this study was of a one experimental and one control group quantitative design, quantitative analysis of data using SPSS, version 22, software was required. The independent variable in the study was using gamified and H5P content for learning along with web conferencing, and the dependent variable was learners' mindset towards learning.

The data gathered through mindset questionnaire and students identified level of general English were analysed quantitatively. Therefore, the question of whether the self-conducted use of gamified interactive content (H5P) for learning in the bichronous (A combination of synchronous and asynchronous modes of technology-mediated classes) format of the LMS can have a significant effect on improving high school EFL learners' Growth Mindset levels was analysed using MANCOVA, since there were covariates that could corrupt data analysis. Respectively, the second research question (i.e., What relationship (if any) is there between different levels of General English (GE) and students' initial mindset rate and type) and the third one (i.e., What relationship (if any) is there between different levels of General English (GE) and the rate of change induced on their Growth Mindset levels through using gamified and interactive content) were analysed using two tests of analysis of variance,

(i.e., ANOVA), since it was the difference in score between pre-test and post-test, with respect to students' level of GE that mattered.

Results and Findings

As stated earlier, the major research question and the purpose of the present study was to investigate whether there existed any relationship between different levels of General English (GE) and the rate of change induced on learners' Growth Mindset levels when using gamified and interactive content, as well as with students' initial mindset levels. After accomplishing the data collection process successfully and gathering the data from both groups through the Mindset questionnaire and tests, the researchers analysed the data (using SPSS). The descriptive results of the analysis, using two types of descriptive statistics, frequency and percentage are described in Table 1 (below).

Based on Table 1 above, in both Experimental and Control groups, there were more students in the Pre-A1 group than the A1 group, and in the A1 group than A2 and above, respectively.

The Experimental group's means and standard deviations show a change between the scores obtained in pre-test and those obtained in post-test of both mindset questionnaires. As can be seen in Table 2 below. The control group, however, does not show significant changes in these scores.

After assuring several assumptions: normality, equality of variances, equality of variance-covariance matrices and homogeneity of regression slopes, a MANCOVA was conducted to determine if the control and experimental groups' mindset has changed significantly (Table 3).

Table 1: Experimental and Control Groups Students Frequency and Percentage in General English Levels

			Level of General English			Total
			Pre-A1	A1	A2	
Student Groups	Experimental	Count	40	36	35	111
		% within group	36.0%	32.4%	31.5%	100.0%
	Control	Count	45	38	31	114
		% within group	39.5%	33.3%	27.2%	100.0%
Total		Count	85	74	66	225
		% within group	37.8%	32.9%	29.3%	100.0%

Table 2: Control and Experimental Groups Mean and Standard Deviation of the Scores of Mindset Questionnaires

Student Groups		Mindset Pre-test Questionnaire	Mindset Post-test Questionnaire
Experimental	Mean	45.513	52.459
	Std. Deviation	16.186	14.757
	N	111	111
Control	Mean	44.131	44.017
	Std. Deviation	16.178	16.234
	N	114	114
Total	Mean	44.813	48.182
	Std. Deviation	16.161	16.056
	N	225	225

Table 3: MANCOVA of Experimental and Control Students' Mindset Based on Using or Not Using Moodle (n = 225)

Source	Sum of Squares	Df	Mean Square	F	Sig.	Eta Squared	Statistical Power
Mindset Pre-test	24140.21	1	24140.21	1126.67	0.001		
Group	3054.35	1	3054.35	142.55	0.001	0.39	0.99
Error	4713.72	220	21.42				
Corrected Total	57747.52	224					

Having eliminated the probable effect of pre-test and taken some error (individual differences) into account, the results of the MANCOVA used for responding to this question show that due to the little significance (sig = 0.001) of the moderator variable (Mindset Pre-test), which is less than 0.05 error, the assumption of linearity of regression of the covariate and dependent variable is correct.

Thus, the main aim of the study is achieved and one can say that the independent variable (i.e., using gamified and H5P content) can influence mindset growth by 39% in Iranian EFL learners at the high school level. Statistical power is reported to be 0.99, which means the possibility of a Type I Error is 0.01.

To achieve the first subsidiary aim and discover whether different levels of General English (GE) have any relationship with students' rate of change induced through using gamified and H5P content on their Growth Mindset levels, the statistical analysis of ANOVA needed to be conducted and therefore, Levene's F-Test (Table 4) was used primarily.

Table 4: Test of Homogeneity of Variances (n = 111)

Levene's Statistic	df1	df2	Sig.
.817	2	108	.445

Since the result of the test of homogeneity was greater than 0.05, conducting an ANOVA was possible.

According to ANOVA results shown in Table 5, since F = 21.81, df = 2, 110, P = 0.001 and therefore significance is smaller than the 0.05 error, one can say that students' level of General English and the amount of mindset change are related. In order to compare the GE levels two by two, a Scheffe test was used.

Based on the result of the Scheffe test shown in Table 6 it can be deduced that mindset differences mean for Pre-A1 (p = 0.001), A1 (p = 0.001) and A2 and above (p = 0.025) are all significant. Comparing the mindset differences means between the three groups, it can be inferred, however, that the Pre-A1 group is the highest in mindset differences mean, while A2 is the lowest. In other words, the weaker the students' level of GE, the higher the amount of change in their mindset type towards a growth one.

Table 5: ANOVA for the Amount of Mindset Change Based on Students' Level of General English (n = 111)

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	1539.204	2	769.602	21.813	.000
Within Groups	3810.471	108	35.282		
Total	5349.676	110			

Table 6: Scheffe Test Results for Comparing Mindset Differences Mean and General English Levels

	GE Level	Pre-A1	A1	A2 and Above	Mindset Differences Mean
Mindset Change	Pre-A1	---	0.001**	0.001**	**11.45**
	A1	0.001**	---	0.025*	**6.33**
	A2 and above	0.001**	0.025*	---	**2.42**

For accomplishing the final subsidiary aim and determine whether different levels of General English (GE) have any relationship with students' initial mindset an ANOVA (as shown in Table 8) was required. Thus, Levene's F-Test was primarily conducted as presented in Table 7.

Table 7: Test of Homogeneity of Variances (n = 225)

	Levene's Statistic	df1	df2	Sig.
Mindset Pre-test	.052	2	222	.949

The result of the test of homogeneity is greater than 0.05, thus an ANOVA was conducted.

In order to inspect the difference between mindset mean scores of each GE level, a one-way ANOVA was used, with the results F = 55.62, df = 2, 222, P = 0.001, which is smaller than 0.05 error. Therefore, it can be claimed that students' GE level and initial mindset levels are related.

For comparing the GE levels two by two, a Scheffe test was conducted regarding initial mindset means as schematized in Table 9.

Based on the Scheffe Table above, it can be deduced that the difference between means of initial mindset levels for Pre-A1 (p = 0.001), A1 (p = 0.001) and A2 (p = 0.001) are significant. Furthermore, the highest initial mean of mindset levels belongs to those with better GE that is A2 and above, and the lowest, to those with weaker GE levels (i.e., Pre-A1).

Table 8: ANOVA for Primary Mindset Levels Based on Students' Level of General English (n = 225)

		Sum of Squares	df	Mean Square	F	Sig.
Mindset Pre-test	Between Groups	19531.006	2	9765.503	55.627	.000
	Within Groups	38973.154	222	175.555		
	Total	58504.160	224			

Table 9: Scheffe Test Results for Comparing Initial levels of Mean Mindset with General English Levels (n = 225)

	General English	Pre-A1	A1	A2	Mindset Mean
Mindset	Pre-A1	---	0.001**	0.001**	33.62
	A1	0.001**	---	0.001**	47.67
	A2	0.001**	0.001**	---	56.01

Discussion

The findings of the present study showed that the use of gamified interactive content (H5P) in the bichronous format of the LMS can have a significant effect on improving high school EFL learners' Growth Mindset levels by 39%. This result is in line with views of certain scholars, who will be referred to below. Moreover, the findings were in contrast with views of certain other scholars [11, 25] since their research studies on the effect of gamification on psychological experiences yielded mixed results [11, 25].

As said above, the asynchronous and synchronous modalities of LMS improved Growth Mindset of the experimental group students in the virtual classes, which were concern of this study. The finding is in agreement with views of a number of scholars [26-28].

The contents, which were provided for students in both gamified and H5P classes, resulted in immediate feedback exchanges, which raised the motivational level and encouraged them to go on with different interactive tasks and activities. This finding is in agreement with the belief of Ibrahim et al. [24] who believed that the immediate feedback in such classes made students motivated and encouraged them to get involved in different activities.

Since the only difference between experimental and control groups was using gamified interactive content for receiving the teaching instructions, what the results suggest is that through using such content, psychological components such as learners' mindset towards learning can be boosted positively. The reason why could be the motivational affordances provided by the gamification, increasing user engagement, essentially getting them more involved in this gamified learning experienced [41], and the students getting into what Gee called the cycle of expertise [42].

If we consider Fogg's Behaviour Model (FBM), this change becomes clearer. FBM claimed behaviour to be the result of a concurrence of a. motivation, b. ability, and c. trigger [42]. In using gamified interactive content, the fun, game-like experience provided a degree of motivation for the students, and the step-by-step format, giving feedback and allowing retries, ensured students' ability to go through the lessons due to its simplicity. Regarding the trigger, learners' logs showed interesting themes. Some students did not seem to need any triggers. Those were the ones who generally finished their tasks right when they were available. Others generally seemed triggered by the fact that they had their synchronous session the day after since their logs showed them to use the website a day before their synchronous session. The compilation of these three factors, motivation, ability, and trigger could be the reason why the students were inclined to use the gamified interactive contents and learn better.

Furthermore, the different levels and the progress bar provided learners with a sense of achievement and unlike traditional learning, learners were able to retry each task and activity several times until they managed to get their desired score. Moreover, achievement probably seemed more attainable for weaker students, since they could refer to the taught materials during the lesson if they wanted to, in order to remember the points taught, which is unlike what happens in classes (and the control group), since the questions the teacher asks during the lesson and the mini-tasks that they assign during the class period cannot be paused in order for the learner to review the teaching instruction they have just received.

These features provided by the gamified interactive content allowed for a shift away from the fixed mindset where the students believed they simply do not have the talent and intelligence required in order to learn English and are incapable of changing that no matter how much they try, towards a Growth Mindset. The challenge they had to face was not as impossible to overcome, failure did not result in shame and they were allowed to redeem their name by trying again, the situation seemed less appalling as the design looks more like a game than a serious classroom, and progress was visible to them in the forms of the levels and progress bars. Suddenly, they were not as stupid in English as they once thought.

As this study focused on blending the asynchronous aspect of e-teaching platforms with the synchronous one, comparing it to its mere synchronous counterpart as the control group, the results showed that the bichronous use of the LMS in itself might not be effective in shifting learners' mindsets towards a growth one unless the features of synchronous and asynchronous modalities are used to their best. Therefore, it can be deduced that not every mode of using technology in its synchronous and asynchronous format results in a higher Growth Mindset.

As a subsidiary aim, this study intended to discover whether different levels of General English (GE) have any relationship with the rate of change induced through using gamified and H5P interactions on learners' Growth Mindset levels. Comparing the mindset differences means between the three groups, the results showed a difference between the three levels of English investigated in the current study, and it was deduced that the Pre-A1 group whose proficiency was below their grade level was the highest in its mindset differences mean and those in the A2 and above group whose proficiency was above their grade level, experienced the least change. In other words, the weaker the students' level of GE, the higher the amount of change in their Mindset type towards a growth one. A reason why could be the fact that weaker learners had not been successful in their English learning previous to taking the course, thus forming a fixed mindset about their lack of ability, talent and intelligence regarding learning English. Therefore, after succeeding in learning English better, their view on this matter shifted, possibly realising they are not without talent, but either have not been working hard enough or going down the right path. Further affirming this point there were some students in the A2 level with average to high Growth Mindsets, who showed almost no difference in their mindset levels.

Another interesting point worth mentioning is the lack of change in the fixed mindset of a minuscule number of students in the A2 and above GE level. An explanation for this might be that these students see themselves as talented in learning English and therefore, progressing in their LMS based course did not relate to hardworking for them, but was a result of their talent and intelligence. This is in line with Dweck's work [31] since she explained that having a fixed mindset is not always specific to students' lack of success in an area.

Lastly, it can also be deduced from the results that the highest initial mean of mindset levels belongs to those with better GE (i.e., A2 and above) and the lowest, to those with weaker GE levels (i.e., Pre-A1). It can be explained that since weaker students had not been successful in their English learning and their exams before taking the course, they had formed a fixed mindset about their lack of ability, talent and intelligence regarding learning English. However, as mentioned hitherto, this was not the case for all the higher

GE level students and though the majority of these students had high Growth Mindset rates, there were those with high fixed mindset rates among them, which is due to their belief in their innate language-learning talent.

Conclusions

In conclusion, this study found that using gamified interactive content in a bichronous use of the LMS can indeed have a positive effect on increasing learners' Growth Mindset especially for those learners with GE levels lower than their grade level. Furthermore, it found that learners' level of GE is related to students' initial rate of mindset, with higher levels of GE pertaining to higher initial Growth Mindset status.

This study can provide researchers in the field of e-teaching with practical information on the benefits of using gamified interactive content in using asynchronous and bichronous LMS based courses. It can also provide teachers with some guideline on how to increase the weaker learners' mindset levels shedding some light on the positive effects of the application of gamified content such as H5P in e-learning on making some changes in the students, their learning style, and their psychological experiences. It is also noteworthy that not every mode of using technology in its synchronous and asynchronous format can necessarily increase Growth Mindset.

The results on the relationship between students' level of GE and their initial rates of mindset can contribute to the concept of growth and fixed mindset, showing a possible relationship between learners' proficiency and their mindset levels. Furthermore, the effect of using gamified interactive content in e-learning on fostering Growth Mindset in learners can assist them in growing into more successful learners, as well as aid teachers in helping their students learn their lessons without necessarily being talented in that area.

Last but not least, this study can help policymakers see the effect the application of the gamification and H5P plugins has on teaching English and can possibly have on other subjects, which can result in new curriculums for schools, grounded on H5P based teaching rather than live teaching using merely web conferencing or messenger apps such as Shad (as a local Iranian platform).

In this study, the researchers faced a number of limitations, which are hoped will not exist for future researchers. One of the limitations was limited subjects available for the research. The only instrument for collection of data in this research was questionnaire. The working conditions and some personal problems, which avoided the teacher to be fully at service of the research should be considered other sources of limitation.

Authors' Contribution

Zari Saeedi's Contributions embody: Conception and design, Analysis and interpretation of data, Critical revision of the manuscript for important intellectual content, Administrative, technical, or material support, Supervision, and 3 rounds of revising the paper. **Niloofar Nikoobin Boroojeni's Contributions include:** Acquisition of data, Analysis and interpretation of data, Statistical analysis, Drafting of the manuscript.

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Conflicts of Interest

The authors have no conflicts of interest.

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AUTHOR(S) BIOSKETCHES

Zari Saeedi received her PhD from the British University of Trinity College (Constituent College of Cambridge) and is an Associate Professor of Allameh Tabataba'i University. She has taught various BA, MA, and PhD courses, taking part in different national/international conferences, presenting/publishing papers/books on a range of topics. Her main areas of interest are cognitive language learning and in particular, Brain Based Language Learning (BBLL), educational neuro/psycholinguistics and brain functioning, culture, technology-assisted language learning, and Role and Reference Grammar Theory of linguistics. Her published paper and book in Benjamins and Equinox publications are among the recent ones. The most recent publication of her is the dictionary of virtual education with a focus on Computer Assisted Language Learning.

Saeedi, Z. Associate Professor, Applied Linguistics, Allameh Tabataba'i University, Tehran, Iran

saeedi.za@atu.ac.ir

Saeediz240@yahoo.com

Niloofar Nikoobin Boroojeni has 9 years of experience in teaching English, holds a CAE certificate, and is a PhD candidate in TEFL. She received her MA degree at Allameh Tabataba'i University. Her main area of interest is LMS based language learning.

Nikoobin Boroojeni, N. PhD Candidate in TEFL, Kharazmi University, Tehran, Iran

Niloofar_nikoobin@atu.ac.ir

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ORIGINAL RESEARCH PAPER

Revitalizing the Potential of CALL with an Ecological Twist: The Impact of an Ecolinguistically-based Task in Fostering Ecological Sustainability Perspectives among EFL Learners

S. S. Hosseini, H. Soleimani*, F. Hemmati, J. Afshinfar

Department of Applied Linguistics and TEFL, Payame Noor University, Tehran, Iran

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* Corresponding author
h_soleimanis@pnu.ac.ir
(+98912) 8516093

ABSTRACT

Background and Objectives: In response to the burgeoning significance of environmental and sustainability education, the educational landscape is undergoing rapid transformations, presenting new opportunities for foreign language classrooms to assume a distinctive role in exposing learners to the fundamental concepts and principles of environmental literacy. Drawing on a newly constructed Ecolinguistic computer-assisted language learning (CALL) evaluation scale, this study aims to investigate the implementation of this scale and the interplay between language, centering on an Ecolinguistically-based task that illustrates the interaction between and among the affordance of technology, the teacher participant's pedagogical considerations and their goal of encouraging learner agency in nurturing learners' ecological perspectives, content aspects, and competency of environmental knowledge.

Methods: A sequential explanatory mixed-methods design was adopted to implement a newly constructed Ecolinguistic CALL perspective to promote environmental literacy among foreign language learners. Two intact classes, including 30 English foreign language learners, were randomly assigned to investigate the implementation of the subscales. A paired-sample t-test was applied to analyze the quantitative data. As part of implementing the Ecolinguistic scale and qualitative data analysis, the participants were assigned an Ecolinguistically technology-based task and were informed about the fundamental concepts of the subscale domains of environmental literacy using a technology-mediated task. Thematic analysis was run to gain a more robust view of the participants' ecological views.

Findings: The study findings unveil a notable and affirmative influence on students' ecological perspectives, as evidenced by the rigorous quantitative data analysis and the participants' thematic analysis reflections. The successful implementation of the Ecolinguistic subscales and the Ecolinguistically-based task significantly bolstered learners' ecological perspectives while concurrently enhancing their comprehension of intricate ecological concepts. These outcomes substantiate the proposition that integrating Ecolinguistic dimensions into technology-mediated pedagogies holds promising potential for cultivating environmental literacy among English foreign language learners.

Conclusions: This research highlights the need to reconceptualize environmental challenges and problematizes the traditional positivist framework underlying mainstream linguistic inquiry. It accentuates the significance of thoughtfully integrating appropriate technologies into language learning environments to enrich students' learning experiences and stimulate motivation that aligns with their individual interests. Moreover, the study underscores the importance of employing practical and cost-effective evaluation techniques to assess students' environmental literacy. The findings yielded by this research endeavor will facilitate and advocate for embracing an eco-dimensional strategy that harmonizes numerous concerns about the volatility of the human habitat and the augmentation of the ecosystem's capacities via the integration of technical concepts, methodologies, and linguistic analysis techniques. This approach endows us with universally applicable to implementing humanitarian endeavors through CALL. It furnishes invaluable perspectives that enrich our comprehension of environmental literacy, thereby bolstering the efficacy of decision-making processes in enhancing our grasp of transformative endeavors within the realms of curriculum design and policy. Several noteworthy limitations warrant consideration. Primarily, the investigation failed to acknowledge the potential ramifications of additional constructs on the subscales of the Ecolinguistic scale. Secondly, the inquiry into the environmental literacy of the participants surpassed the confines of the study's purview. Notwithstanding these limitations, the study's findings and methodologies have propelled our comprehension of environmental literacy to new heights. Nonetheless, further measures are imperative to bolster curriculum design and policy formulation decision-making processes. The study carries substantial implications for pedagogy and academia, encompassing the enhancement of environmental literacy among English as a Foreign Language learners and the cultivation of a comprehensive approach to language acquisition. Additional research is indispensable to delve into the pedagogical preferences of educators, regulate variables, and encompass a more expansive sample size. Educators are strongly encouraged to adopt student-centered, transformative pedagogies while simultaneously ensuring equitable access to technology-driven resources. A thorough understanding of sociolinguistics and a thoughtful consideration of technological affordances also assume pivotal roles in this endeavor.

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مقاله پژوهشی

تقویت ظرفیت یادگیری زبان به کمک رایانه با پیچ و تاب زیست محیطی: تأثیر یک تکلیف مبتنی بر رویکرد زبان شناسی زیست محیطی به کمک فناوری در تقویت دیدگاه های پایدار زیست محیطی در بین فراگیران زبان انگلیسی

سارا سادات حسینی، حسن سلیمانی*، فاطمه همتی، جعفر افشین‌فر

گروه زبان و ادبیات زبانهای خارجی ، دانشگاه پیام نور، تهران، ایران

چکیده

پیشینه و اهداف: در پاسخ به اهمیت روزافزون آموزش های زیست محیطی پایدار، چشم انداز های آموزشی دستخوش دگرگونی های سریعی می شود و فرصت های جدیدی را برای کلاس های درس زبان های خارجی ارائه می کند تا نقشی متمایز در آشنا کردن زبان آموزان با مفاهیم و اصول اساسی سواد زیست محیطی ایفا کنند. این پژوهش با بهره گیری از مقیاس توسعه یافته جدید ارزشیابی یادگیری زبان به کمک کامپیوتردر زبان شناسی زیست محیطی، با هدف بررسی و پیاده سازی این مقیاس و تأثیر متقابل آن با زبان و با تکیه بریک تکلیف درسی مبتنی بر زبان شناسی زیست شناختی که تعامل بین زبان زیست شناختی و فناوری را نشان می‌دهد، صورت گرفته است. ملاحظات آموزشی معلمان شرکت کننده و هدف آن‌ها از تشویق جنبه‌های عاملیت فراگیران در پرورش دیدگاه‌های زیست شناختی، جنبه‌های محتوایی و توانایی دانش زیست محیطی آن ها را نشان میدهد.

روش‌ها: یک طرح تحقیقی ترکیبی توضیحی متوالی برای پیاده‌سازی دیدگاه یادگیری زبان به کمک رایانه در زبان شناسی زیست محیطی برای ارتقاء سواد زیست محیطی در بین زبان‌آموزان اتخاذ شد. دو کلاس خارج از طرح کنترل شامل ۳۰ دانشجو ی زبان انگلیسی به طور تصادفی به بررسی اجرای خرده مقیاس ها اختصاص داده شدند. برای تجزیه و تحلیل داده های کمی از آزمون تی زوجی استفاده شد. به عنوان بخشی از اجرای زبان شناسی زیست محیطی و تجزیه و تحلیل داده‌های کیفی، به شرکت‌کنندگان یک تکلیف آموزشی مبتنی بر مفاهیم زیست محیطی به کمک فناوری محول شد که در آن دانشجویان در مورد مفاهیم اساسی حوزه‌های خرده مقیاس سواد زیست‌محیطی آگاهی یافتند. همچنین برای به دست آوردن یک دیدگاه قوی‌تر از دیدگاه های زیست محیطی, تجزیه و تحلیل موضوعی از شرکت کنندگان به عمل آمد.

یافته‌ها: نتایج مطالعه تأثیر قابل‌توجه و مثبتی بر دیدگاه‌های زیست‌محیطی دانشجویان نشان داد، کماینکه تحلیل دقیق داده‌های کمی و بازتاب تحلیل موضوعی شرکت‌کنندگان نیز حاکی ازین مسئله بود. اجرای موفقیت‌آمیز خرده مقیاس‌های زیست‌محیطی و تکلیف محوردر زبان‌شناسی به طور قابل‌توجهی دیدگاه‌های زیست‌محیطی دانشجویان را تقویت کرد و همزمان درک آن‌ها را از مفاهیم پیچیده اکولوژیکی افزایش داد. نتایج این گزاره اثبات می‌کند که ادغام ابعاد زبانشناسی زیست محیطی در آموزش های مبتنی بر فناوری ظرفیت امیدوارکننده ای برای پرورش سواد زیست محیطی در بین زبان آموزان است.

نتیجه‌گیری: این تحقیق بیانگر نیاز مبرم به مفهوم‌سازی مجدد و حل چالش‌های زیست محیطی میباشد و بیانگر چارچوب فلسفی مثبت و عملی سنت گرایی در جریان اصلی تحقیقات, میباشد. اهمیت ادغام متفکرانه فناوری‌های مناسب در محیط‌های فراگیری زبان برای غنی‌سازی تجربیات یادگیری دانش‌جویان و انگیزه آنان, همسو با علایق فردی شان می‌شود . لذا این مطالعه بیانگر اهمیت کاربرد تکنیک‌های ارزشیابی عملی برای ارزیابی سواد زیست محیطی

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دیدگاههای اکولوژیکی فراگیری زبان به کمک رایانه
مقیاس ارزیابی زبان شناسی زیست محیطی با کمک کامپیوتر
فراگیران زبان انگلیسی
تکلیف مبتنی بر تکنولوژی
سواد زیست محیطی

*نویسنده مسئول
h_soleimanis@pnu.ac.ir
۰۹۱۲-۸۵۱۶۰۹۳

دانش‌جویان میباشد. نتایج این مطالعه، پذیرش یک استراتژی زیست‌بعدی را که نگرانی‌های مربوط به نوسانات زیستگاه انسانی و افزایش ظرفیت‌های اکوسیستم از طریق ادغام مفاهیم فنی، روش‌شناسی و زبان‌شناسی است را هماهنگ، تسهیل و حمایت می‌کند. تکنیک های تجزیه و تحلیل این رویکرد ابزارهای قابل اجرای جهانی جهت تلاش‌های بشردوستانه از طریق فناوری به ما ارائه می‌دهد. تکنیک های تجزیه و تحلیل این رویکرد، ابزارهای قابل اجرای جهانی و دیدگاه های ارزشمندی را جهت تلاش‌های بشردوستانه از طریق فناوری به ما ارائه می کند تا درک ما از سواد زیست محیطی افزایش یابد و در نتیجه، کارایی فرآیندهای تصمیم‌گیری ما در تقویت بینش مان از تلاش‌های تحول‌آفرین در حوزه‌های طراحی برنامه درسی و سیاست گذاری تقویت می شود. بررسی چندین محدودیت قابل توجه در این مطالعه اهمیت دارد. در ابتدا، این تحقیق نتوانست نتایج بالقوه دیگر سازه‌ها را در خرده مقیاس‌های زبان شناسی زیست محیطی تأیید کند. ثانیاً، تحقیق در مورد سواد زیست محیطی شرکت کنندگان از محدوده قلمرو مطالعاتی فراتر نرفت. علیرغم محدودیت‌ها، یافته‌های این مطالعه و روش‌شناسی، درک ما را از سواد زیست محیطی به افق های جدیدی سوق داده است. لذا، اقدامات بیشتر برای تقویت فرآیندهای تصمیم گیری در مورد طراحی برنامه درسی و ضرورت تدوین سیاست‌های مناسب احساس می‌شود. این مطالعه کاربردهای قابل توجهی برای آموزش و دانشگاه دارد که شامل افزایش سواد زیست محیطی در بین دانشجویان و پرورش یک رویکرد جامع برای فراگیری زبان است. تحقیقات بیشتری برای بررسی ترجیحات آموزشی مربیان، تنظیم متغیرها و در بر گرفتن حجم نمونه گسترده تر ضروری است. مربیان تشویق می‌شوند تا آموزش‌های دانشجو محور و نوآورانه را اتخاذ کنند و همچنین به منظور اطمینان از دسترسی عادلانه به منابع فناوری، تلاش نمایند.

Introduction

In recent years, there has been a surge of interest in incorporating computer-assisted language learning (CALL) programs to bolster learners' environmental literacy [1],[2],[3]. As an overarching domain of applied linguistics, CALL can be situated at the confluence of various academic disciplines [4]. In a parallel fashion, the interplay between language and communication has assumed a pivotal role in the realms of Linguistics and Language Education, constituting a salient domain of scrutiny that furnishes illuminating perspectives and direction for practical pedagogical approaches [5]. Linguistics, as a dynamic scientific field, adapts itself to the new systemic reality of ecology. This perspective can be split into dual variations; the initial postulates a clear demarcation between language and environment, whereas the latter presupposes their function as a complex system comprising interconnected entities [6].

As the field of Linguistics has progressed to a point, it no longer requires coddling from the sophistication and lucidity of information derived from reality. Rather, it actively seeks out novel methodologies to delve into the "actual" reality. As Larsen-Freeman posits, "this ecological orientation paves the way for the future" [7, p. 110], indicating that an ecological perspective in language teaching involves recognizing that learning is meaningful when students are instructed to embrace and encounter the language reality through pedagogical processes, affordances, and ecological artifacts. Seen in this way, learning a language entails undergoing a process of development that transforms human agency into fully functional agents with distinct characteristics.

Correspondingly, Ecolinguistics as a subfield of linguistics delves into the intricate relationship between language and the environment and opens up a novel trajectory in linguistics to extend the human vision of language and life [8]. From this angle, the study may further call for deeper assumptions of interdisciplinary domains, including CALL pedagogy, through theoretical, empirical, or experiential means. In light of this, it can be posited that the fundamental assumptions inherent in linguistic practices have the potential to shape one's attitudes and

behaviors toward the natural ecology as they reflect on the natural world and indicate that the field did not arise from a single investigation but evolved in collaboration with external aspects of the environment and animal world [9]. Furthermore, integrating Ecolinguistic facets into CALL-based pedagogies may challenge instructors to commit themselves to this new educational vision and redefine their views of teaching practices.

The rapidly escalating deterioration of our natural environment has necessitated a critical reassessment of the positivist framework that has traditionally underpinned mainstream linguistic inquiry. Steffensen and Fill [10] argue that the conventional notion of science as a linear progression towards greater understanding, improved methodologies, and societal advancement warrants scrutiny. Henceforth, Ecolinguistics, driven by an unwavering commitment to ecological and dialectical epistemologies, harbors profound theoretical and practical implications for concerted endeavors of humanity in tackling the increasingly dire state of global ecological crises.

Conversely, trends in CALL roughly parallel those in other areas of applied linguistics. In contemporary education, it is incumbent upon teachers to assume the responsibility of steering the use of classroom technology toward positive outcomes. To this end, they must deliberate on how to seamlessly integrate technology into daily classroom activities to enhance learning experiences, foster motivation, and align with the personal interests of students [11],[12]. Of particular significance is the imperative to meticulously discern and select apt technologies that effectively fulfill precise educational aims, while concurrently assessing the methodologies employed by educators within their unique teaching contexts [13].

Apropos of the stance elaborated above, this study aimed to elucidate how the developed Ecolinguistic CALL Evaluation scale (ECES) can be implemented, thereby showcasing the extent to which the language users and learners can act as ‘social agents’ to engage with sociopolitical, cultural and biological tenets of environmental literacy within the mesh of ecological trail. In the current investigation, the ECES valence constructs were delved deeper to be developed by the researcher to assist in procuring information regarding students' environmental literacy, Eco-literacy, and the substance of ecological knowledge to scrutinize the role of natural ecology in shaping solutions to resolve environmental issues in education. Implementing Ecolinguistically CALL-oriented tenets can potentially augment the fundamental environmental literacy of English foreign language (EFL) learners at its core, thereby advancing their overall comprehension of ecological concepts and principles. The constructs played a prominent role since they assisted learners in using their individual skills and competencies to reach an objective. Prior to delving into the methodological design, it is imperative to take a brief retrospective look at the theoretical underpinnings of the study.

Review of the Related Literature

Theoretical Framework

The theoretical framework of this study draws upon and is inspired by several prominent theories in the field. These theories include Bronfenbrenner's Ecological Systems Theory [14], Chaos and Complexity Theory [15], and Van Lier's [16] work. Bronfenbrenner's Ecological Systems Theory provides a conceptual framework that recognizes the dynamic interaction between individuals and their environmental contexts, highlighting the

influence of various systems at different levels (e.g., microsystem, mesosystem, exosystem, macrosystem). Chaos and Complexity Theory emphasizes language learning processes' complex, interconnected nature, acknowledging the non-linear and unpredictable dynamics that emerge in educational contexts. Complex Adaptive Systems Theory further contributes to this framework by emphasizing the adaptive nature of language learning systems, where learners and their Environment co-evolve and mutually influence each other. Non-linear Dynamic Systems Theory acknowledges the dynamic and non-linear nature of language learning, emphasizing the emergence of patterns and behaviors that are not easily predictable or explainable through linear cause-effect relationships. Lastly, Van Lier's work provides insights into the ecological dimensions of language learning, highlighting the reciprocal relationship between learners and their social and cultural contexts. By incorporating these theoretical perspectives, the present study aims to provide a comprehensive understanding of how implementing Ecological Complexity in Environmental Contexts and its subscales can influence the ecological perspectives of EFL learners. In so doing, the study seeks to explore practical and cost-effective evaluation methods for assessing students' Environmental Literacy. In the grand scheme, this theoretical framework provides a rich foundation for investigating the complex and dynamic nature of language learning in environmental contexts and contributes to the broader field of language education and ecological perspectives.

Ecolinguistic Turns

Considering the genesis of Ecolinguistics, it is imperative to examine both ecological and linguistic issues. Nevertheless, Ecolinguistic scholars have proffered numerous pivotal conceptualizations that have been regarded as crucial [17], environmentally significant [18] and ecologically centered [19],[20],[21], epistemologically-oriented [8], as well as scientifically informed [22]. Our investigation concentrated on the environmental facet Steffensen and Fill [10] designated as the critical turn within the Ecolinguistic paradigm, seeking to comprehend the intricacies inherent in the language and the simultaneous endeavors to transcend the confines of academic circles, aiming to heighten awareness regarding the inextricable interplay between linguistic practices and the ecological perils we face. It references the need for a reconceptualization of environmental problems and the nature-culture dichotomy.

Anthropocentrism

The human dimension of Ecolinguistics can be comprehended in terms of the subjects of Ecolinguistic inquiry and the Ecolinguists themselves as researchers and observers. Firstly, human activities have a double-edged role in the ecology of the Earth, with devastating impacts in the Anthropocene era. Secondly, as Halliday [17] recognized, linguists possess the capacity to account for ecological issues and, in so doing, ecologize human behavior.

Environmental Literacy

Environmental education has undergone a diverse and multi-dimensional transformation since the inception of the Tbilisi Conference, which laid the groundwork for environmental literacy (EL), highlighting the process of augmenting individuals' comprehension, consciousness, abilities, and dedication to tackle environmental predicaments [23]. As a Comprehensively instrumental approach, environmental education recognizes the importance of knowledge acquisition, skill

development, and fostering attitudes necessary for responsible environmental stewardship through which Environmental literacy can be developed [24],[25]. EL is often viewed as a continuum ranging from limited awareness and basic knowledge of the Environment to a more thorough understanding of the interactions between social and natural systems, along with the ability to communicate and take action effectively [26]. The continuum also includes deeper levels of environmental literacy, such as the composite framework created by the North American Association for Environmental Education (NAAEE) for the National Environmental Education Guidelines Project, which explicitly incorporated socio-political foundations, the functional knowledge that transcends specific domains, insight into the cultural and social roles of the natural world, and the critical capacity to analyze environmental and societal issues that challenge prevailing norms and ideologies. Linguists operate within the academic and professional spheres to advance the field of linguistics, and they also play a crucial part in maintaining the ecosystem to ensure global well-being in tandem with life sustainability [10].

Of equal significance, a multitude of principles possess the capacity to augment the outcomes pertaining to environmental literacy in online programs. These principles encompass the interconnections between social-ecological domains, the pertinence and applicability of the content, the facilitation of social interactions, role models, the cultivation of autonomy, active engagement of learners, the introduction of challenging tasks, the utilization of diverse modalities, the adoption of a positive framing approach, adequate preparation, the provision of constructive feedback, and the encouragement of reflective practices [27].

Furthermore, a significant corpus of research has been undertaken on environmental knowledge, attitudes, and actions among primary and secondary school populations, higher education, and the general population worldwide. The bulk of the studies utilized quantitative methods for data collection (e.g., [28],[29],[30],[31],[32] to name a few. However, given the predominantly quantitative nature of these studies, it is plausible that more appropriate sampling techniques, context-sensitive research instruments, and advanced statistical analyses could have yielded more robust statistical findings. Most studies reported a positive attitude towards the Environment, with varying levels of environmental knowledge. Nevertheless, a comprehensive inventory of socio-ecological concepts tailored explicitly for the environmental literacy domain has yet to be examined.

Ecological principles and other tenets derived from natural sciences served as fundamental pillars underpinning environmental education and examining ecological challenges. In a similar vein, concepts originating from the social sciences assume a crucial role in this endeavor. Regardless of the volume of ecological knowledge pertinent to a particular issue or the proposed resolution, the intricate mechanics of decision-making unfold within the domain of the social sciences. As Hungerford and Peyton [33] aptly noted, it is in the realm of the social sciences where the pragmatic intricacies of decision-making find their home, transcending the mere influence of ecological knowledge on the problem at hand or its prospective solution.

Given the paramount importance of environmental literacy and the socio-pragmatic domain of environmental literacy, it is imperative to recognize the significance of sociopolitical underpinnings as part of the

cognitive element of environmental literacy [34] to analyze and assess environmental issues and potential technological means.

This evaluation aimed to assess students' application of environmental knowledge and competencies in practical, real-world settings. Such assessments contribute to a holistic comprehension of students' environmental literacy and offer valuable insights for devising educational strategies that foster sustainable behaviors and informed decision-making.

This paper highlights the importance of assessing ECES subscales and the limited availability of data on the current status of ecological perspectives in CALL-oriented settings. Due to the emerging threats of environmental destruction caused by technological breakthroughs and the dearth of a comprehensive outline or inventory of social-ecological concepts tailored explicitly for environmental education, scholars are urged to work with their peer linguists to challenge language in the context of society and ecology and to address environmental problems through education. By delving further into the role of the researcher-observer, it can better be realized how linguists contribute to the field of environmental literacy. Examining the perspectives and experiences of Ecolinguists as they engage with ecological phenomena can enrich our comprehension of the complex relationship between language, humans, and the environment. This deeper exploration elucidates the interconnectedness between anthropocentrism, environmental literacy, and the imperative to cultivate sustainable behaviors and informed decision-making. By integrating these theoretical perspectives and in order to address the gaps in this study, the following research questions were formulated:

Q1. Does implementing the Ecolinguistically CALL-based task affect the ecological perspectives of EFL learners?

Q2. How can evaluating students' EL, particularly their practices in problem identification, analysis, and assessment of possible environmental technology-mediated task responses, be conducted practically and affordably?

Method

Participants

Adopting purposive sampling procedures, several stakeholders (i.e., students and academics) in Iran were surveyed in Iran to yield their responses to some of the administered subscale constructs representing the socio-ecological view of environmental literacy. The participants comprised 30 male and female students of undergraduate English major students and academics. Fifteen learners were assigned to the experimental group and 15 to the control group. The group's ages ranged from 20 to 35 (M=24.87, SD= 3.421). The participating EFL learners took a two-credit audio and visual translation course as part of their bachelor's program. The second segment of the participants comprised six experts from academia. Homogeneous sampling for this subgroup of participants was employed to ensure their homogeneity and interest in the phenomena of interest. They comprised two males specialized in environmental science education, one in mathematics and one doing a degree in engineering, and two female educators in applied linguistics (M=37.50, SD=3.146), including the researcher. The experts were also members of the Society for the Prevention of Cruelty to Animals (S.P.C.) and a Non-Governmental Organization), (NGO), the largest advocacy organization for animal rights and the Environment in Iran, which provided us with qualitative data and exclusive access to mentorship opportunities on several dimensions of biologics to approach our query

from an environmental lens to reach a full-spectrum view.

Instruments

ECES Subscales

As the study is mainly grounded on assumptions and interpretive and methodological approaches of Complex dynamic systems theory (CDST), the ECES, a newly constructed survey-based design instrument developed by Hosseini et al. [35], served as a guiding framework and a cost-effective, reliable instrument in line with these premises. The instrument used in the study was a researcher-made novel questionnaire with 46 questions, of which 11 items were picked to obtain data on students' environmental literacy, Eco-literacy, content aspects, and competency of ecological knowledge. The ECES presented a validated evaluation tool with an acceptable reliability index of .862. to measure ideological, sociological, and biological dimensions with 14 constructs and 46 items defined by the researchers. The ECES was further broken down into distinct subscales honing in on environmental literacy measurement essential to investigate the contribution of natural ecology in CALL-oriented settings.

YouTube Documentary

A CALL-mediated task (an original supplemental CALL environmental literacy material sample) from a YouTube documentary, [36] 'Fighting Fire with Fire: Can Fire Positively Impact an Ecosystem?' contributed as an affordance to direct the teachers' strategies to reach the study's goal. As Ecolinguistics seeks to create linguistic theories that include human beings as an integral part of the larger ecosystems upon which all life depends, it was hoped to demonstrate how language can be applied to resolve pressing ecological issues such as biodiversity loss and environmental injustice.

Interview

As previously stated, a quasi-experimental pretest-posttest research design was utilized, wherein qualitative data collections were conducted to complement and further explicate the findings. Additionally, several methods were utilized to collect qualitative data, including semi-structured interviews, the think-aloud protocol, the co-discovery method, and the self-reporting log method. The semi-structured interviews were conducted both on-site and via telephone for 10-15 minutes, with questions collaboratively constructed by a group of specialists in the field and pilot-tested prior to data collection. (See Appendix A for the list of questions).

The interview protocol was reviewed by a panel of experts and external reviewers to ensure validity and reliability. Inter-rater reliability checks were performed for consistency in coding and analysis. After testing, the logs were collected and analyzed. The interviews focused on key questions of ECES subscale items in English, and participants were provided with printouts of their responses and asked to explain their rationale. The study terminated the interviews when saturation was reached regarding research inquiries, and substantially no more forthcoming information was provided. These methods were chosen for their ability to provide substantial qualitative data while ensuring validity and reliability.

The think-aloud protocol, a standard method, provided a significant amount of qualitative data and was utilized on the grounds of its accessibility. During this process, participants were instructed to articulate their thoughts out loud as they carried out the designated tasks. Their verbal expressions and

corresponding actions were documented for later analysis. Concurrently, the co-discovery method, which involves collaborative work among students on a prescribed task, was also employed. The participants' interactions were observed, and they were encouraged to vocalize their thoughts and interactions during the task, subsequently documenting and analyzing their recorded statements. Moreover, the self-reporting log method, which required participants to maintain a journal to record their actions and thoughts while performing the tasks, was found to be very useful for individuals with limited oral proficiency in English. After testing, the logs were collected, and the written data were examined.

Procedures

In this study, an intervention was employed to examine the impact of an Ecolinguistically CALL-based task and the ECES subscale dimensions on the ecological perspectives of EFL learners. Two intact classes were selected, and a CALL-mediated task from a YouTube documentary was selected within which the biological, sociopolitical, and cultural tenets pertinent to the ECES were identified and elucidated. The task was completed in eight 20-minute sessions, where the learners were also engaged with multiple controlled burn scenarios and probed into the reasons for intentional and prescribed forest wildfires in Iran. The study utilized the five E models (engage, explore, explain, elaborate, and evaluate) to design the supplementary activity and evaluated the effectiveness of the subscales in task fulfillment and their potential to promote environmental literacy in a CALL-specific setting. Prior to the intervention, a pretest was administered to assess participants' ecological perspectives, content aspects, and competency of ecological knowledge. During the implementation phase and further to quantitative data collection analyses, participants were informed about the fundamental concepts of the environment to foster a robust understanding of environmental literacy domains. Quantitative data obtained from the ECES were analyzed using a paired-sample *t-test* to measure the effectiveness of the intervention.

Additionally, thematic analysis was run through reflective analyses of participants' responses, aiming to gain deeper insights into their ecological perspectives. Moreover, the audio and pdf files of the participants' reflective insights were received via social media platforms and further listened to, analyzed, and transcribed by the researcher to gain a retrospective reflection of their experience. While qualitative work is not designed to provide generalizable statistics regarding trends, it may lay the groundwork for subsequent quantitative research, which we cover in further depth below. Alternatively, this investigation phase aimed to use a CALL-centric task to shed light on the contextualized and interrelated ECES subscales that influence students' environmental literacy, decision-making, and adoption of interventions.

Design

A sequential explanatory mixed methods design was adopted in this study. Subsequent to collecting the quantitative data, the researchers sought to explain findings from the quantitative assessment by conducting and analyzing qualitative data, usually from a smaller number of subjects. As the researchers had access to quantitative instrument design for measuring the constructs of interest, they returned to the participants for the second round of qualitative data collection to synthesize the findings.

Results and Finding

The Quantitative Analysis

The quantitative portion of this study is focused on descriptive-inferential statistics. To compare the experimental group's means, a paired-sample t-test was run on the pretest and posttest of environmental literacy to probe the null hypothesis. Besides, Cronbach's alpha reliability indices were employed for the pretest and posttest of the ecological perspective, and the sample means of the two tests were compared. Later, a descriptive technique was used in qualitative analysis to examine the data obtained through reflective journals and interviews.

In order to investigate the research question, "Does the implementation of the Ecolinguistically CALL-based task influence the ecological perspectives of EFL learners?" and as part of the quantitative evaluation, the essential subscale dimensions in alignment with the environmental literacy facets extracted from the ECES subscales were measured. This online assessment included measures of People, Places, and Environment, Ecolinguistics and Ecojustice behavior, Multimodal Interactive Learning, and Ecological Discourse Analysis. Besides, the effect of the ECES constructs and its subscales was determined on the environmental literacy of EFL learners using semi-structured interviews and a technology-mediated task. The research question was analyzed through a Paired-sample t-test, which assumes the normality of the data. As represented in Table 1, the ratios of skewness and kurtosis over their respective standard errors were within the ranges of ±1.96; thus, it was concluded that the present data did not show any significant deviation from normality.

Table 1: Cronbach's Alpha Reliability Coefficient for Ecological Perspective

	Cronbach's Alpha	N of Items
Pretest	.892	11
Posttest	.894	11

The Ecological Perspective was measured through 11 items. Table 2 displays the results of Cronbach's alpha reliability coefficients of the pretest and posttest measures of the Ecological Perspective. The two tests enjoyed reliability indices of .892 and .894.

George and Mallery [39] have caution ed that there is no universally accepted criterion for what constitutes an acceptable alpha value. They note that a rule of thumb that can be applied to most situations is that an alpha value of >.9 is excellent, >.8 is good, >.7 is acceptable, >.6 is questionable, >.5 is poor, and <.5 is unacceptable. Based on these criteria, it can be concluded that the pretest and posttest measures of the Ecological Perspective exhibited good reliability indices, with values of at least .80. This indicates that the measures were internally consistent and can be considered reliable for assessing the construct of interest.

Table 2: Normality Indices for Skewness and Kurtosis coefficients of the sample

	N	Skewness		Kurtosis		Ratios	
	Statistic	Statistic	Std. Error	Statistic	Std. Error	Skewness	Kurtosis
Pretest	30	.191	.427	-.941	.833	0.45	-1.13
Posttest	30	-.112	.427	-.769	.833	-0.26	-0.92

A paired-sample t-test was conducted to compare the experimental group's pretest and posttest measures of ecological literacy. The results showed that the posttest mean score (M = 29.43, SD = 8.14) was significantly higher than the pretest (M = 20.47, SD = 7.28). This suggests that the ECES effectively increased participants' ecological literacy. The findings, reported in Table 3, indicated a significant difference between the pretest and posttest scores [t (29) = 14.03, $p < .05$, r = .983], with a large effect size. As a result, the null hypothesis stating that the intervention had no significant effect on ecological perspectives was rejected.

The Qualitative Analysis

Thematic analysis

The qualitative data from the semi-structured interviews and the practices were assessed, while the student's responses regarding their emergent environmental issues were analyzed. To this end, a set of a priori codes was assigned to segments of texts. Open thematic coding was employed as excerpts were collated for the sake of codification and identification of the overarching themes. (e.g., prescribed fire, wildfire, human-ignited fires, & fire management strategies). Various standards were employed as guides while the data was thematized. First, the nexus between the subscale criteria and Eco-literacy components was identified. Second, we sought how the pertinent ECES subscales contributed to the students' EL in the task practice.

Considering this theoretical stance, the data was coded in two distinct ways: inductively, based on the emerging themes, and deductively, using the study's theoretical underpinnings. For example, when a code from the dataset was relevant to how the fire had contributed to the role of climate and climate-fuel interactions, it was coded as 'Climate-Vegetation Feedback' as related to Environmental knowledge and cognitive element of EL. This coding procedure was done to reach themes across the data. After reviewing the dataset, the themes were aggregated, condensed, and applied to previous and subsequent transcripts. Clusters of interrelated subthemes were identified through axial coding. The generated codes in each cluster were then used to label each cluster. Contextual factors were also coded based on the task, inductively building subthemes (e.g., Political dynamics mismanagement, incentives, local/ tribal politics, biophysical conditions, climate change, and health) as the data was analyzed. The coding approach allowed the researchers to analyze and organize data related to our inquiry, with themes informed by the theoretical literature while identifying emergent themes that may not have been anticipated. Later, the three steps of open coding, axial coding, and labeling were tested for interrater reliability [37]. Therefore, the dataset was reviewed and cross-checked by one of the researchers and an environmental expert [38] to verify the analyses and resolve the existing discrepancies.

Table 3: Paired-sample t-test for Pretest and Posttest of Ecological Perspective

Paired Differences						
Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference	T	df	Sig. (2-tailed)
		Lower	upper			
8.967	.639	7.660	10.273	14.038	29	.000

Then, the researchers got engaged in the discussion of the data and its analysis to (1) gain a better grasp of the analysis procedure; (2) discuss the coding process to refine, cross-reference, and compare the codes and their associated categories; (3) increase the reliability of the analysis through peer discussion and the development of clearly-defined categories; and (4) rule out the possibility that the study did not satisfy its theoretical foundations (i.e., the three components of knowledge, dispositions, and competencies). The studies surrounding EL components were finalized, and the CALL-oriented assignment was completed after the codes and categories were refined, the data was member-checked, and the interviews were integrated and compared to reach a consensus on the emerging themes.

Thematic Analysis Findings

Table 4 presents the data's overarching codes, themes, and sample extracts across the given task regarding knowledge, dispositions, and competency.

Data Sources

Using the criteria in Table 4, the gathered evidence (i.e., interviews, questionnaire items, and the discussions from the watched video) and several interview questions were gleaned. As was explained below, knowledge, dispositions, and competencies were used in parallel with [40],[41],[42],[26] as coding categories, with each representing an essential part of EL. It was illustrated how environmental particularities and their subcomponents exerted power sources on the students' EL across various stages as we navigated the vodcast, preceding or following the task. Knowledge of how to effectively address environmental issues is what made up the bulk of environmental literacy content domains, knowledge of the physical and ecological systems, the environmental concerns, the sociopolitical domain, and the methods for resolving these issues. Figure 1 illustrates the induced elements of the Environmental literacy framework. Students, educators, and activists revealed their positive and negative perceptions of the subscales in a CALL-mediated task, which functioned as a robust tool shaping their knowledge, dispositions, and competencies.

Insights from the Reflections

Based on the induced data, the participants initially had nebulous views about the efficacy of controlled burns, but after participating in structured and communicative discussions, they valued the task discussions related to environmental issues in a biodiversity context.

Table 4: Codes, Themes, and Sample Extracts

Themes	Subthemes	Examples
Prescribed fire (Humans contribute to altering fire regimes and are impacted by them)	Fire and above-ground biodiversity Fire-vegetation feedbacks	Example: Neda Well, I reckon many species need fire to propagate; most invasive species suffer significant declines in the aftermath of a fire, opening the door for native ones to reclaim their territory. It also leads to the health of plants and can influence their regrowth, reproduction, and germination.
	Fire Effects on below-ground ecology Fire Effects on soil physical, chemical, and biological properties Ecological consequences of temporal and spatial variation in soil properties influenced by fire	Example: Amir Hossein On the bright side, I suppose fire enriches the soil quality by nurturing the recycling of nutrients or slowing the growth of weedy plants that might otherwise smother newly planted seedlings. On the dark side, it leads to erosion and sedimentation, and some animals/plants may unintendedly be killed/injured.
	Climate-vegetation feedbacks The Role of Climate and climate-fuel Interactions	Example: Alireza To my mind, increasing fire activity can reduce ecosystem carbon dioxide storage globally. Fire-induced vegetation change can alter regional climate. Aerosols emitted during fire combustion could also significantly impact regional and global climate.
Wildfire	Burns Climate change and health Mercury and health Mental health	Example Kimia: Wildfires have a pernicious effect on mental health and psychosocial well-being. PM2. 5-minute toxic particle matter is found in high concentrations in the smoke, which may even be absorbed through the epidermis. Particles breathed go far into the lung tissue. Strokes, asthma, and heart attacks result from any of them. The current research also confirms that tiny particles lodge easily into the brain.
Human-Ignited fires	Local/Tribal	Example: Mohsen I think most forest fires are human-ignited. Either unintentionally or deliberately (Tribal conflicts). The sun is concentrated on a dry fuel patch by various sources, including cigarettes, campfires, burning trash, military ammunition, and even a discarded glass bottle laid by humans.
Fire management strategies	Political Dynamics Mismanagement	Example: Afsoon My view on the matter is that some of the root reasons for the biased decision-making amid emergency response typically involve general decision biases, leadership and team dynamics, lack of equipment, and variations in perspectives between top executives and incident management teams, leading collectively to severe damage to the Environment.

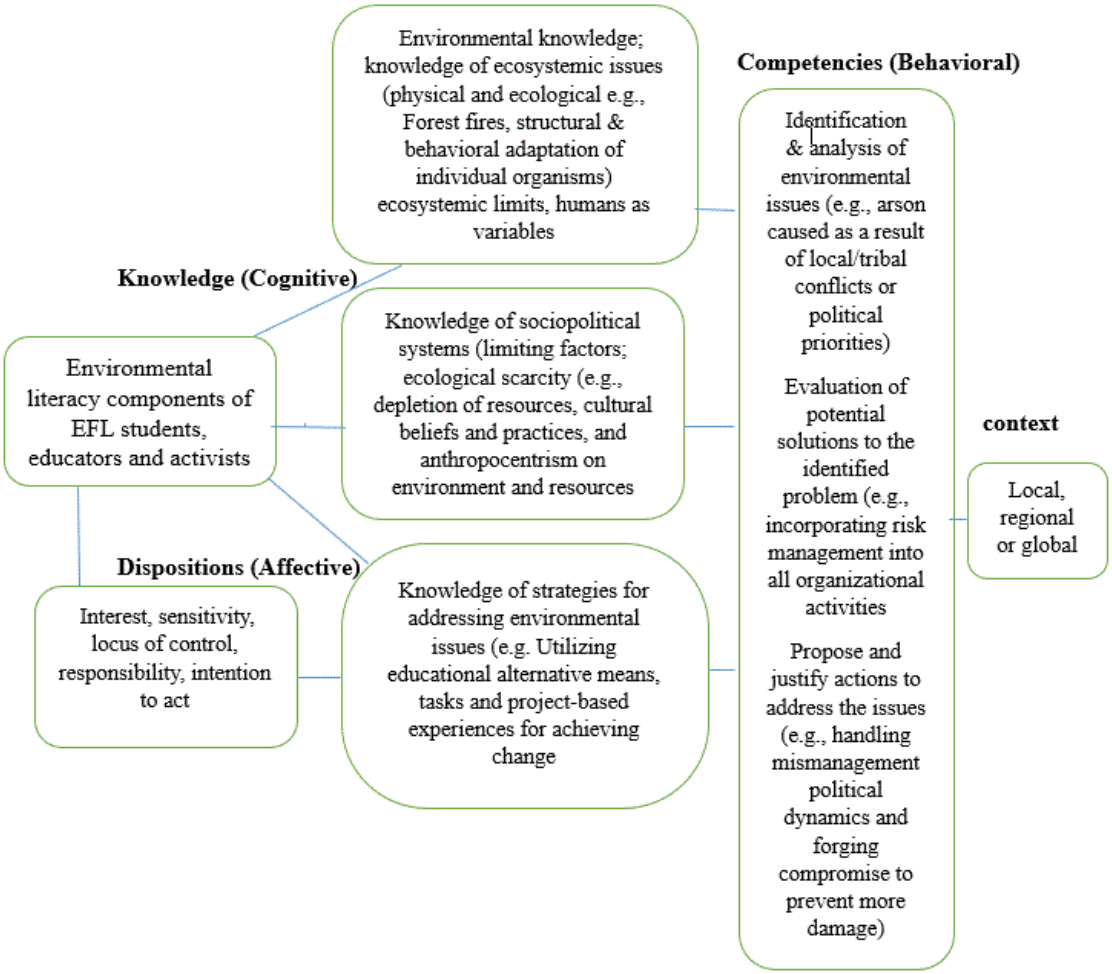

Fig. 1: Induced Elements of Environmental Literacy Framework

The students expressed their perceptions about the causes of human-caused wildfires, fire management strategies, and the role of risk management in wildfire response, underscoring the importance of balancing different variables and developing risk-informed, strategic innovations to aid decision-makers during wildfire event response. To their knowledge, effective risk management requires an analytical and preventative strategy considering contextual variability, uncertainty, and the best available data for decision-making.

The received data provided a comprehensive analysis of the impact of fire on biodiversity, ecology, and climate change. One of the key themes was prescribed fire, which explored how human contributions to altering fire regimes impact biodiversity and vegetation feedback. While fire can benefit plant health and open the door for native species to reclaim their territory, it can also lead to unintended animal/plant deaths, injuries, and erosion. Another important subtheme was the impact of fire on below-ground ecology and soil properties, where the fire could enrich soil quality by nurturing nutrient recycling but also lead to sedimentation and the slowing of plant growth. Climate-vegetation feedback was another critical subtheme, with Alireza, a participant, suggesting that increasing fire activity can reduce ecosystem carbon dioxide storage globally and alter regional climate.

Additionally, wildfires have a pernicious effect on mental health and psychosocial well-being due to high concentrations of particulate matter (PM2). Five-minute toxic particle matter

in the smoke can lead to strokes, asthma, and heart attacks. Moreover, the presented data examined human-ignited fires and their impact on biodiversity, ecology, and climate change, with Mohsen suggesting that most forest fires are human-ignited, unintentionally or deliberately, due to tribal conflicts. Finally, the data discussed fire management strategies and the political dynamics involved in mismanagement, where biased decision-making during emergency response can lead to severe damage to the environment due to general decision biases, leadership and team dynamics, lack of equipment, and variations in perspectives between top executives and incident management teams. Overall, the analysis underscored the complexity and multifaceted nature of fire's impact on the environment, with both positive and negative consequences. It highlighted the importance of understanding the ecological consequences of fire and the need for effective fire management strategies to minimize its adverse effects. Furthermore, the data emphasized the critical role of human behavior in shaping fire regimes and the need for greater awareness and responsibility to mitigate its impact on biodiversity, ecology, and climate change.

Based on the induced data of the second part of the study drawn from the thematic analysis [43] and to address the second research question of the EFL students, educators, and activists in the identification of issues and strategies in an environmental scenario within the CALL-oriented setting, four overarching themes emerged: (1) There is a limit to how far individual actions may go toward solving environmental issues, as environmental issues are intricate. 2) The preconceived notions about sociopolitical and cultural beliefs that create roadblocks to implementing systemic changes in environments and resources at the local, regional, and global levels. 3) The role of digital technology in fostering environmental literacy, and finally, 4) Challenging Anthropocentrism through Multimedia Resources. Table 5 summarizes the two overarching themes and example extracts induced from the participants.

Table 5: Overarching themes addressing the functional, cultural, and critical perceptions of participants toward environmental literacy

Themes	Description	Level	Example
Limitations of Individual Actions	Environmental issues are complex and multifaceted, and while individual actions can make a difference, they have limitations in terms of solving more significant environmental problems.	Functional	Original text: Azadeh: Collectively speaking, human assemblies, or governments, are now engaged in activities that will impact the interconnected web of life that we refer to as the "environment." As politics influence the disposition of governments and how those governments may and will affect the Environment, it is essential for all human beings in the world to voluntarily persuade governments to secure a future that includes a healthy environment responsibly.
Sociopolitical and Cultural Roadblocks	Preconceived notions about social, political,	Cultural and Critical	Original text: Saman: Personally, I do not feel very optimistic as I think these efforts and

Themes	Description	Level	Example
	and cultural beliefs can act as barriers to implementing systemic changes in environments and resources at the local, regional, and global levels.		footprints can hardly amount to a drop in the ocean. It is hard to make a giant impact without top-down systemic changes. The time for action is dire. We are deep into an irreversible trend of environmental disasters, and the officials just blamed the collective irreversible changes, and by this, they have concluded that the issue is already closed to debate. For them, including activism and support in the curriculum is futile and unnecessary.
Challenging Anthropocentrism through Multimedia Resources	The negative impact of anthropocentrism on the environment, including the devaluation and demeaning of nature and the belief in human domination over creation.	Critical	Original text: Amin: I feel our Environment is an intricate web. Nothing exists in a vacuum. Yet, people behave as if our actions have no consequences and are not separated from the web of life. Until humanity can curb its numbers and give up anthropocentrism and its negative impacts on the Environment, we will have environmental problems. Therefore, using digital platforms could widen the reach and scope of teaching and Learning.
The role of digital technology in fostering environmental literacy.	Raising ecological awareness and encouraging action towards environmental sustainability.	Functional	Original text: Banafshe: From its onset, social media has served as a platform for the EFL teaching community, activists, and every layman to raise their voices and concerns on environmental issues over and above the hazards of anthropocentrism on the social landscape. Images, videos, games, memes, and campaign commercials detailing simple steps that anybody Can do to make the world a cleaner and greener place is multimedia sources. Videos showing the potential disaster that might befall our planet if environmental deterioration continues have raised consciousness and galvanized a desire for action. In a nutshell, multimedia resources undeniably play a pivotal role in elevating global ecological awareness for the EFL teaching community.

Collectively speaking, analysis of the participants' reflections revealed that students, teachers, and activists were of varying EL levels. As they explained their thought processes in issue identification, teacher participants with more experience provided more nuanced and intricate explanations. There is also a more powerful combination of social and ecological concerns. When comparing and contrasting problems, it was figured out that the contextual view of EL proposed by Stables [26] (functional, cultural, and critical levels) played a role. Critical-level individuals were grappling with the social repercussions of environmental issues.

The concept of socio-ecological systems and disposition was taken for granted at the functional level but deemed insufficient to promote necessary action in the contextual view of EL. Students were inspired to engage in the cultural knowledge practices and behaviors of experts by being exposed to and learning from them. Peer effects on identification may be at play among activists and environmental students because 1) they are more likely to hold a degree in environmental studies and 2) they are more likely to work in settings with a social cohort that is environmentally conscious or engaged.

All else being equal, it was assumed that students' environmental literacy could be appraised practically and affordably by developing a digital application that provides resources and guidance to users on environmental issues and concerns. This may help students get hands-on experience with coding and building an application that can aid others in learning about and taking action toward environmental issues. Students could create digital presentations or infographics on environmental topics of their choice, thus helping students apply their knowledge of technology and environmental issues creatively and positively. Additionally, digital communication gizmos, such as social media and online forums and videos, augmented reality simulations for environmental education, and gamification can be used to assess students' understanding of environmental issues and their involvement in related issues and discussions.

Discussion

Inspired by Bronfenbrenner's Ecological Systems Theory [14], Chaos and Complexity Theory [15], and Van Lier's [16], this paper has explored the implementation of the Ecolinguistic CALL Evaluation Scale (ECES) from three angles: a quantitative analysis of the key subscale dimensions in alignment with the environmental literacy facets pulled from the ECES; an examination of the effect of implementing the ECES constructs and its subscales on the environmental literacy of EFL learners and assessment of practices in addressing the participants' collaborative investigation and identification of issues and strategies in promoting environmental literacy. The qualitative data also illuminated the interconnection of ECES subscales and the ecological perspectives of participants. The results of the analyses of the participants' reflections and implementation of the constructs of ECES subscales indicated a positive, significant effect on the ecological perspectives of participants.

As to our research question in implementing the constructs of ECES and its subscales to affect the ecological perspectives of EFL learners and based on the conceptual framework of environmental literacy formerly outlined, the concepts through subscales and reflective practices were represented to collect evidence of students' sociopolitical, cultural and environmental knowledge. The four primary content domains comprising the framework were the knowledge of physical and ecological systems, environmental issues, sociopolitical knowledge, and strategies for addressing environmental issues. Notably, concepts of the subscales were taken from the social sciences, including anthropology, sociology, political science, and technology embedded within the CALL domain.

At first glance, the study seemed to overemphasize the role of environmental issues of concern and Ecolinguistics in the current ecological meaning of the Physical

Environment. This sophomoric view somewhat contradicted the pivotal position accredited by Van Lier [16] to the role of teacher and students' agency and the Environment in a sense encompassing all the physical, social, technological, and symbolic affordances that can steer a classroom debate to a fruitful end. The proposed stance also aligns favorably well with the words of Garrett [11], Warschauer, and Cook [12] for teachers in directing classroom activities with technology incorporation, thus making learning more rooted in students' interests.

On second thought, the distinction provides different perspectives on Language's Environment: Each provides a figure-ground constellation that emphasizes one ecological dimension without discounting the other two. This is in good agreement with the natural ecology view and concurs well with Halliday's perspective and the notion of the transformative effect of language on ecology [44], the complementarity of the field of applied linguistics and its contribution to maintaining nature for life sustainability and global well-being further corroborated by Alexander and Stibbe [10].

Based on participants' reflections, one way the teacher employed to practically and affordably evaluate students' EL was to have students assess and develop ideas of how concerning resources and guidance could assist with environmental concerns. This could help students get hands-on experience with coding and building a set of themes that could aid others in learning about and taking action toward environmental issues. Some even created digital presentations or infographics on environmental topics of their choice. This helped students apply their knowledge of technology and environmental issues creatively and positively. Additionally, the students put forward digital communication tools such as social media and online forums to assess their understanding of environmental issues and their involvement in related issues and discussions. This view is in good agreement with the words of Halliday [17] that through digital technology, linguists can bring ecological issues into account, and, in so doing, researchers can ecologize human behavior.

Regarding the interconnection between environmental literacy, digital affordances, and anthropocentrism, it can be argued that among the crucial constructs of the subscales and the online social platforms that reflect the community's power to construct every individual's life and mind, such as beliefs, ethics, and political awareness and the precepts further proposed by [45] of goal-oriented of general education are the human actions having both positive and negative repercussions on the Environment. Environmental literacy veritably sets the parameter in recognizing and perceiving the relative health of environmental systems and taking appropriate action to preserve, restore, and enhance the health of those systems. Based on Roth [45] and the results drawn from the environmental experts in this study, formal environmental education was substantiated to draw its strength mainly from several macro issues, including the interrelationships between natural and social systems, the unity of humankind with nature, contextual and cultural values embedded within the affordance of technology, the making of choices and the developmental learning throughout the human life cycle. We purportedly proved that improving an individual's environmental knowledge results in more favorable attitudes towards the Environment [46], which in turn

may assist in developing more responsible environmental behavior (however, the educational and communicative link between cognitive and affective components and the overall behavior follows a complex non-linear pattern). In alignment with earlier findings regarding environmental knowledge not being a sole precursor, we figured out in a comparable vein that it can act as a linchpin to promote and lead to environmentally responsible behavior among individuals.

Concerning the moral and ethical standpoints, the targeted participants were examined on their reflective insights on one of the subscale issues related to anthropocentrism and eco-centric lines of consciousness. As this model of consciousness is based on the assertion that humans should not be esteemed as the core element of the universe but a part of the natural Environment, eco-centric consciousness was found to be associated correspondingly with the issues of diversity and harmony of Man's coexistence in a natural environment rather than of intellectual domination and global convenience. This view lent support to 'Ecologization' in humanitarian sciences being sparked by the need to investigate the social and cultural life of peoples through the paradigm of their Environment [47],[48],[49], as educators have time and again transformed far beyond the biological sense of ecology and integrated this notion with humanitarian task implementation and bore a broad vision on their understanding of the universe, human nature, agents' role, and education's significance. This is partly due to language education, which is morally and ethically concerned with issues such as the impact of ecological relations on technology, language development, identity formation, human well-being, and life sustainability. Axiologically speaking, the significance of protecting natural environments ran counter to the anthropocentric worldview, as quoted by one of the participants of this study. Similar views lead many to believe that ecological ethics principles are much more crucial to the question of human existence than anthropocentric notions of worth.

Conclusions

In conclusion, as an interdisciplinary study, this investigation examined the effects of the treatment implemented via the ECES subscale constructs on the environmental literacy of EFL learners. Results revealed that EFL students' environmental attitudes, reflective insights, and perceptions markedly improved. The ECES was enlarged as the study attempted to represent how the ecological model of language learning could provide a theoretical lens through which students' CALL practices are explored to encourage learner agency. Given the role of technology in bringing diversity to the classroom as leverage to draw out learners' agency in improving EL, the analysis centered on a technology-mediated task that illustrated the interaction between and among the affordance of technology, the teacher participant's pedagogical considerations, and their goal of encouraging learner agency in addressing and promoting environmental literacy. These three strands weaved together to provide a consummate picture of the setting and a springboard for future research on EL in the classroom.

The implications of this study for both the pedagogical and academic domains are significant. Firstly, implementing the approach examined in this study has the potential to improve the environmental literacy of EFL

learners significantly. Secondly, the holistic view of language learning and development espoused by ecological linguistics has the potential to have a profound and beneficial impact on the advancement of linguistics, pedagogy, education, and other disciplines. This approach considers all aspects of the Environment and situation of the learner, in contrast to traditional approaches to CALL evaluation that focus solely on the language per se. Implementing both of these approaches could provide learners with valuable insights into their understanding of environmental literacy practices, especially in our ever-changing and technology-driven world. However, further research is needed to explore teachers' pedagogical choices based on the perceived technological affordances and interactions between teacher and student agency mediated by these affordances in the classroom ecology. As multiple contributing factors may affect the results of this kind of study, it is essential to control the variables and carefully account for any confounding factors. Future research should also study a more extensive sample composed of other stakeholders and transdisciplinary domains. This would necessitate novel research that seeks to fill in knowledge gaps when seen through the lens of heuristic and transdisciplinary frameworks. The study encourages teachers to adopt more student-centered, transformational, and experiential pedagogical stances with regard to environmental literacy in the classroom. It is also necessary to ensure that the technological resources used in CALL are accessible to all learners and that technology-based learning resources and materials are appropriate for the diverse linguistic identities of learners and their communities, promoting equity and inclusivity in CALL contexts.

A host of potential limitations need to be considered in this study. To begin with, as to the multifaceted concepts existing within the ECES subscales, the effects of the scores of other remaining constructs were overlooked. Second, although the reflective insights of the participants were investigated, the examination of their EL was not put into action as it was beyond the scope of this study. This study's results and applied approaches have conceivably been promising and have made notable strides in augmenting our comprehension of the EL at hand, providing valuable insights that have contributed to a deeper and more nuanced understanding of the phenomenon under investigation. However, some course of action still needs to be taken. The best-case scenario occurs when such efforts will have value in supporting more effective decision-making and augmenting our understanding of systemic change initiatives in the context of curriculum design and policy.

Recommendations of this study may include understanding the sociolinguistics of language learners and their communities, including their language variation, use, and attitudes, and the broader social elements that may influence language learning. Additionally, it is essential to consider the affordances of the tools, their support for language learning, and how they may align with ecological and socio-pragmatic perspectives.

Overall, the fact that language comprises a vast array of concepts and permeates nearly every aspect of human existence makes the application of Ecolinguistic analysis and principles pervasive. This implies that human interaction can be the subject of diverse hypotheses. Thus, learners can develop environmental literacy as the first stage toward a more comprehensive understanding of

interaction with ecological aspects, namely to develop an organic understanding of the world and participation in environmental action.

Last but not least, the findings of this research will enable and recommend the adoption of an eco-dimensional approach that balances a number of issues relating to the instability of the human Environment and the expansion of the ecosystem's capabilities through the incorporation of technical concepts, methods, and techniques of linguistic analysis. This approach grants universal instruments for the implantation of humanitarian tasks through CALL. It provides valuable insights that contribute to a deeper and more nuanced understanding of environmental literacy, supporting effective decision-making in augmenting our understanding of systemic change initiatives in the context of curriculum design and policy.

Authors' Contribution

The first author handled data acquisition, did the write-up, and provided administrative, technical, and material support. The first and corresponding authors were involved in data analysis and interpretation. The manuscript drafting was collaborative, with all authors contributing their expertise. Each author was crucial in reviewing and revising the manuscript for scholarly integrity. The supervisory committee provided valuable guidance throughout the research process.

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Conflicts of Interest

We have no conflicts of interest to disclose, and there has been no financial support for this novel work that could have influenced its outcome.

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AUTHOR(S) BIOSKETCHES

Hosseini, S.S is a Ph.D. candidate in applied linguistics at Payame Noor University, Tehran, Iran; she is a university instructor and has taught in reputable language institutes. She completed her M.A. course at Kharazmi University. Intrigued by the nexus of technology, politics, sociology, and anthropology, she probes into their interplay with Ecolinguistics and pedagogy in the CALL milieu.

Hosseini, S.S, Ph.D. Candidate of Applied Linguistics, Payame Noor University, Tehran, Iran.

sarah_hosseini110@yahoo.com

Soleimani, H is the Associate Professor of Applied Linguistics at Payame Noor University, Tehran, Iran. Dr. Soleimani received his Ph. D. in applied linguistics from Isfahan University in 2008. He has authored several books, including *Computer Assisted Language Learning: Theory and Practice* (PNU University Press) in 2021, *Non-parametric Statistics for Applied Linguistics Research* in 2010, and a chapter in *Issues in Materials Development* by Sense Publishers, the Netherlands, in 2016. He is the author of several articles and has presented some papers at conferences. His special interests are SLA issues in general and computer-assisted language learning in particular. He teaches CALL, Materials Development, and First Language Acquisition at the PNU Ph.D. post-graduate school and Tehran University.

Soleimani, H., Associate Professor of Applied Linguistics, Department of TEFL and English Literature, Payame Noor University, Tehran, Iran.

h_soleimanis@pnu.ac.ir

Hemmati, F is the Associate professor of TEFL at Payame Noor University, Tehran, Iran. She has been teaching TEFL courses for more than 30 years and has authored two books focusing on EFL Writing. She has published more than 60 articles, and her main interests are classroom discourse analysis, writing skills, and teacher education.

Hemmati, F., Associate Professor of Applied Linguistics, Department of TEFL and English Literature, Payame Noor University, Tehran, Iran.

Hemmati@pnu.ac.ir

Afshinfar, J is an Assistant professor of TEFL at the Department of English, Faculty of Literature and Foreign Languages, Payame Noor University, Tehran, Iran. He has been lecturing at undergraduate and graduate levels as well as researching for more than 20 years. His research interests are mostly in the areas of first and second language acquisition, teaching methodology, materials development, and teacher education.

Afshinfar, J., Assistant Professor of Applied Linguistics at Payame Noor University, Tehran, Iran.

ja.afshinfar@pnu.ac.ir

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ORIGINAL RESEARCH PAPER

Exploring the Relationship among Various Forms of Social Support, Academic Engagement, and Technology Anxiety amidst the COVID-19 Pandemic: An investigation of mediation and moderation effects

M. Noorolahei, H. Zangeneh*, M. Pourjamshidei

Department of Educational Sciences, Faculty of Human Sciences, Bu-Ali Sina University, Hamedan, Iran

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* Corresponding author
Zangeneh@basu.ac.ir
(+9881) 38292614

ABSTRACT

Background and Objectives: The central objective of the educational system is to cultivate student success, promote academic progress, and foster meaningful and enjoyable learning experiences. Achieving these aims hinges significantly on student engagement in the learning process, as its absence may lead to academic failure and suboptimal outcomes. Numerous factors influence students' academic engagement quantity and quality, warranting thorough investigation. This need has been accentuated by the widespread implementation of virtual education during the COVID-19 pandemic, which has been associated with declining academic performance and reduced interest in learning among students. In response to this challenge, examining the factors that impact academic engagement, including the support provided by teachers, parents, and classmates, and integrating new technologies that have become integral to the educational landscape is essential. However, utilizing these new technologies also brings unique challenges, notably technology anxiety, wherein students may experience fear and apprehension when confronted with technology-related tasks. The present research explores the relationship between the type of social support and learners' level of academic engagement, considering the mediating and moderating role of technology anxiety. By elucidating such relationships, this study aims to propose innovative and contemporary solutions that effectively harness social support, ultimately ensuring educational success and fostering positive learning experiences amidst the complexities of modern education.

Materials and Methods: The research adopted a quantitative and survey-correlation methodology. The statistical population comprises 528 eighth-grade high school students (264 girls and 264 boys) from Famnin City during the academic year 2021-2022. Initially determined as 225 individuals using Karajesi and Morgan's table and selected through random cluster sampling, the sample size was later increased to 402 participants (221 girls and 181 boys) to enhance generalizability. The research instruments consist of Reeve's 2013 Academic Engagement Questionnaire, Dimrai and Maleki's 2002 Social Support Questionnaire, and Bandalos and Benson's 1990 Computer Anxiety Questionnaire. Convergent and divergent validity assessed the items' validity, while Cronbach's alpha, combined reliability, and Spearman's tests measured item reliability. The presented model and results were analyzed using structural equations and Spearman's correlation test.

Findings: The findings from the structural equations analysis indicate a significant relationship between social support and the extent of student academic engagement mediated by technology anxiety. The social support provided by parents, teachers, and classmates exhibits both direct and indirect effects on students' academic engagement. This support, comprising instrumental, informational, emotional, and evaluative aspects, positively influences students' engagement in various technological aspects, including communication, work success, confidence, and intimacy. Consequently, technology anxiety is reduced, increasing academic engagement across behavioral, cognitive, emotional, and causal dimensions. Furthermore, this positive effect remains evident even when not considering technology anxiety as a mediating factor.

Conclusions: The research findings highlight the crucial and fundamental role of parents, teachers, and classmates in addressing students' challenges, particularly in the realm of technology and its application in education. These key stakeholders can provide essential support to students, facilitating the resolution of technological issues. Recognizing their significant impact, policymakers and educational authorities should harness these valuable resources to enhance the quality of online education. Implementing targeted programs and plans to encourage parents, teachers, and classmates to offer increased social support will ultimately improve the overall learning experience and academic engagement.

NUMBER OF REFERENCES	NUMBER OF FIGURES	NUMBER OF TABLES
68	2	15

مقاله پژوهشی

بررسی رابطه‌ی بین انواع حمایت اجتماعی با درگیرسازی تحصیلی از طریق نقش میانجی و تعدیل‌کنندگی اضطراب فناوری طی دوره کرونا

مصطفی نورالهی، حسین زنگنه*، مریم پورجمشیدی

گروه علوم تربیتی، دانشکده علوم انسانی، دانشگاه بوعلی سینا، همدان، ایران

چکیده

پیشینه و اهداف: تمام تلاش‌های نظام آموزشی در راستای موفقیت، پیشرفت تحصیلی و ایجاد یادگیری‌های عمیق و لذت بخش در دانش‌آموزان است. این امر بدون درگیر شدن دانش‌آموزان در فرآیند یادگیری امری غیرممکن است که نتیجه‌ای جز شکست و عدم موفقیت در پی نخواهد داشت. اما کمّیت و کیفیت درگیری تحصیلی دانش‌آموزان متأثر از عوامل گوناگون و مختلفی است که توجه و بررسی آن ها امری لازم و ضروری است. چنین ضرورتی با شیوع کووید ۱۹ و آغاز آموزش‌های مجازی که همراه با افت تحصیلی و عدم علاقه و لذت یادگیری در دانش‌آموزان بود بیش از گذشته آشکار شد. با بررسی و مطالعه عوامل تاثیرگذار بر درگیری تحصیلی می‌توان به حمایت معلمان، والدین و همکلاسی‌ها و همچنین فناوری‌های نوینی که امروزه جز جدایی ناپذیر جریان آموزش شده‌اند اشاره کرد که قادر هستند باعث ارتقا کمی و کیفی درگیری تحصیلی شوند؛ اما استفاده از فناوری‌ها نوین نیز، چالش‌های پیش روی خود را دارا بود. یکی از این چالش‌ها اضطراب فناوری بود. زمانی که دانش‌آموزان هنگام مواجه با فناوری‌ها، دچار اضطراب و ترس می‌شدند و لزوم حل چنین مشکلی اجتناب ناپذیر بود. لذا این پژوهش با هدف بررسی رابطه‌ی بین حمایت اجتماعی با میزان درگیرسازی تحصیلی یادگیرنده با نقش تعدیل‌گری و میانجی اضطراب فناوری انجام شد تا راهکارهای متفاوت و بروزی را ارائه کند که در چنین شرایطی نیز حمایت‌های اجتماعی اثرگذار باشند و در نتیجه شاهد موفقیت امر آموزش و یادگیری باشیم.

روش‌ها: روش پژوهش کمّی و از نوع پیمایشی- همبستگی بود. جامعه آماری این پژوهش شامل ۵۲۸ نفر (۲۶۴ دختر و ۲۶۴ پسر) دانش آموزان پایه هشتم متوسطه شهرستان فامنین بود که در سال تحصیلی ۱۴۰۱-۱۴۰۰ مشغول به تحصیل بودند. حجم نمونه بر اساس جدول کرجسی و مورگان ۲۲۵ نفر و به روش خوشه‌ای تصادفی انتخاب گردید، اما به دلیل اطمینان بیشتر این نمونه به ۴۰۲ نفر (۲۲۱ دختر و۱۸۱ پسر) تغییر یافت. ابزارهای پژوهش شامل پرسشنامه درگیرسازی تحصیلی ریو ۲۰۱۳، پرسشنامه حمایت اجتماعی دیمرای و مالکی ۲۰۰۲ و پرسشنامه‌ی اضطراب رایانه باندالوس و بنسون ۱۹۹۰ بود. روایی ابزاهای پژوهش بر اساس روایی همگرا و واگرا موردسنجش قرار گرفت. پایایی ابزارها نیز بر اساس آزمون آلفای کرونباخ، آزمون پایایی ترکیبی و آزمون اسپیرمن موردسنجش قرار گرفت و مدل ارائه شده و نتایج حاصل از طریق معادلات ساختاری و آزمون همبستگی اسپیرمن مورد بررسی قرار گرفت.

یافته‌ها: نتایج معادلات ساختاری نشان داد که بین حمایت اجتماعی با میزان درگیرسازی تحصیلی یادگیرنده با نقش میانجی اضطراب فناوری رابطه معناداری وجود دارد و حمایت اجتماعی والدین، معلمان و همکلاسی‌ها نیز به صورت مستقیم و غیرمستقیم بر درگیرسازی تحصیلی دانش‌آموزان تاثیرگذار است. حمایت اجتماعی والدین، معلمان و همکلاسی‌ها که به صورت حمایت‌های ابزاری، اطلاعاتی، عاطفی و ارزیابی ارائه شدند در سه بخش ارتباط دهی با فناوری، موفقیت کار در فناوری و اطمینان و صمیمت در فناوری موجب کاهش اضطراب فناوری و افزایش درگیری تحصیلی دانش‌آموزان در چهار بعد درگیری رفتاری، شناختی، عاطفی و عاملی شد. همچنین این تاثیر به صورت مستقیم و بدون در نظر گرفتن اضطراب فناوری نیز صادق بود.

نتیجه‌گیری: با توجه به نتایج پژوهش والدین، معلمان و همکلاسی‌ها با ارائه حمایت‌های لازم می‌توانند در حل مشکلات و چالش‌های پیش روی دانش‌آموزان نقشی مهم و اساسی ایفا کنند. به ویژه اگر این مشکلات و چالش‌ها در

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حمایت اجتماعی
درگیری تحصیلی
اضطراب فناوری

*نویسنده مسئول
Zangeneh@basu.ac.ir
۰۸۱-۳۸۲۹۲۶۱۴

حوزه فناوری و کاربرد و استفاده آن در امر آموزش باشد. به همین دلیل سیاستگزاران و مسئولان آموزش و پرورش برای ارتقا کیفیت آموزش‌های مجازی نباید از این ظرفیت‌های بزرگ چشم پوشی کنند و با برنامه‌ها و طرح‌های لازم موجب تشویق والدین، معلمان و همکلاسی‌ها دانش‌آموزان گردند تا به ارائه حمایت‌های اجتماعی بیشتر روی آورند و کیفیت آموزش و یادگیری را بهبود بخشند.

Introduction

Over the past few decades, empirical research has consistently demonstrated that academic engagement plays a crucial role in shaping students' learning outcomes, academic progress, success, and overall retention rates, ultimately contributing to the enhancement of educational quality [1-4]. The outbreak of the Coronavirus pandemic further emphasized the significance of academic engagement as conventional pedagogical approaches rapidly transitioned to virtual instruction, leading to a profound transformation in the educational landscape. This abrupt shift placed students in an uncharted learning environment heavily reliant on new educational technologies as a fundamental prerequisite for their scholastic endeavors. Despite initial expectations of positive outcomes, this transition gradually resulted in declining interest and decreased participation in academic activities and homework completion, necessitating renewed efforts to fortify students' cognitive engagement [5].

Academic Engagement encompasses several facets that reflect students' emotional, cognitive, and behavioral involvement in their learning activities and homework [6]. This active participation is characterized by a high level of mental energy and mental activity, leading to sustained effort and a sense of enjoyment throughout the learning process, making time feel inconsequential [7]. *The cognitive engagement* involves students' self-regulated learning, the use of advanced learning strategies, and persistent efforts to grasp complex concepts [8]. *Emotional engagement* encompasses both positive emotions, such as interest, happiness, and joy, as well as negative emotions, including stress, anxiety, sadness, discomfort, and shame, concerning schooling and the learning process [8]. *Behavioral Engagement* is observable through actions such as students' commitment, attentiveness to teachers, active classroom participation, and timely homework completion [6] [8-10]. Reeve and Tseng [11] also introduced a fourth dimension known as '*agentive engagement*,' which underscores students' active involvement in determining the learning content and shaping the learning environment [12]. Learning technologies are pivotal in engaging students academically through diverse design strategies [66&67]. However, their utilization often triggers learner anxiety toward technology [68]. It necessitates employing various forms of social support to manage and regulate this aspect effectively [42&43].

Many studies have been done in the field of managing technology anxiety through social support [40&43]. Still, uncertainties persist regarding the distinct roles played by parents, teachers, and classmates in delivering social support to mitigate technology anxiety. It remains unclear whether all of these sources impact technology anxiety or if only certain ones are influential. To assess the effectiveness of social support in reducing technology anxiety, a comprehensive investigation into its delivery methods and underlying mechanisms is imperative. Moreover, the study examines whether technology anxiety operates as a mediating or moderating factor in the relationship between social support and

academic engagement. Understanding the nature and dimensions of this effect is critical. Thus, this research seeks to address these gaps in knowledge and unveil the intricate connections between social support, academic engagement, and technology anxiety within the educational technology context, specifically focusing on their implications for student well-being and learning outcomes. As a result, the following research questions are formulated:

Q 1. To what extent does technology anxiety mediate the relationship between social support and the academic engagement levels of learners?

Q 2. To what degree is there a statistically significant relationship between the social support provided by teachers and the academic engagement levels exhibited by students?

Q 3. To what extent is a statistically significant relationship between parental social support and students' academic engagement levels?

Q 4. To what degree is there a statistically significant relationship between the social support received from classmates and the academic engagement levels demonstrated by students?

Q 5. To what extent does technology anxiety act as a moderating factor in the relationship between social support and the academic engagement levels of learners?

Review of the Related Literature

Numerous factors, including environmental influences, significantly impact learners' academic engagement quantity and quality. Drawing inspiration from Bronfenbrenner's ecological system theory [13], we understand that learners are intricately shaped by their surroundings. Key components of this environment, such as family, teachers, friends, and classmates, play pivotal roles as proximal and influential factors. This network of individuals can considerably influence academic engagement by providing various support forms [14-15]. These supportive measures are commonly referred to as 'social support' and have been the subject of extensive investigation, particularly in the context of academic engagement. The relationship between social support and academic engagement has been a focal point in numerous studies, underscoring its critical role in shaping learners' educational experiences.

Social support represents a connected network of relationships that aids individuals in dealing with challenges and stressful situations by offering both material and psychological resources [16]. In the realm of educational technology, social support encompasses communication and interactions between learners and various key figures, including family members, friends, teachers, and peers. These interactions lead to exchanging information, knowledge, and practical problem-solving strategies for personal, work-related, and educational matters [17]. Extensive research has uncovered many benefits of social support in enhancing academic engagement. For instance, it has been shown to reduce stress levels [18-19], boost self-confidence, and nurture close and supportive relationships [20-21]. Additionally, social support has a positive impact on learners' perceptions of academic tasks and assignments, ultimately increasing their satisfaction with school [22]. Moreover, it aids in completing school assignments [23] and contributes to developing creative thinking skills [24]. These diverse dimensions of social support collectively contribute to its profound influence on nurturing and sustaining academic engagement among learners.

Social support, sourced from parents, teachers, classmates, and friends, takes various forms, including informational, instrumental,

emotional, and evaluative support. Each of these forms plays a pivotal role in promoting academic engagement. Information support involves the provision of advice, guidance, and essential information to help students address challenges and achieve their academic goals [25]. Instrumental support, on the other hand, encompasses tangible assistance by providing necessary facilities, equipment, and financial resources to support students' academic endeavors [16]. Emotional support involves feelings of love, affection, care, confidence, and respect, which are offered unconditionally and without discrimination. This type of support creates an encouraging and nurturing atmosphere [26]. Lastly, evaluation support pertains to receiving constructive feedback that enhances performance and refines approaches to various academic tasks [27]. Through these distinct dimensions, social support cultivates an environment that fosters students' academic engagement and overall success in their educational journey.

Technologies hold significant relevance in influencing academic engagement, with modern devices like mobile phones, computers, and tablets often serving to enhance and increase students' active participation in learning [28-31]. Through their potential to motivate and engage learners, technologies can accelerate skill development, enrich educational experiences, and foster connections between school learning and real-world practices [32]. Embracing technologies can lead to transformative changes in the educational landscape, bolstering teaching practices, facilitating school-world communication, and ultimately fostering greater student engagement in the learning process [33]. However, the prevalence of technology anxiety represents a notable barrier to the full utilization of available technologies. Technology anxiety encompasses negative emotions such as distress, fear, restlessness, and discomfort experienced by users when interacting with digital devices like computers, mobile phones, and tablets [34-35]. Consequently, learners may avoid or limit technology usage due to fear and apprehension [36-37]. Providing comprehensive support from various sources is essential to mitigate technology anxiety, as it can empower learners to overcome their apprehensions and embrace technology more effectively [38-40]. In an efficient educational system, recognizing technologies as indispensable tools for engaging students and improving educational quality becomes not only a choice but a crucial necessity.

Salas et al. [41] conducted a study exploring the dynamics of teacher-student relationships, peer support, family support for learning, and school participation perceptions among both regular and special needs students. Their findings indicated a favorable level of these factors, with special needs students exhibiting higher levels of cognitive, emotional, and social engagement indicators than their typically developing peers. However, no significant differences were observed between the two groups in terms of behavioral indicators. Lee et al. [42] investigated the interplay between the quality of educational software (APP), computer anxiety, and students' engagement. Their research revealed that computer anxiety significantly influences the relationships between student participation, interface quality, and service quality, mediating the system's quality. Moreover, instructor quality directly mediated the relationship between computer anxiety and students' participation. Meanwhile, Zhou and Yu [43] examined the impact of social support on the well-being of Chinese students undergoing home quarantine during the COVID-19 pandemic. The study demonstrated a stronger positive association

between online learning self-efficacy and well-being in students who do not experience anxiety while quarantined at home. Additionally, Weinert et al. [40] found that social support positively affects end-user performance while simultaneously reducing technical fatigue and physiological arousal. Instrumental support was directly linked to end-user performance, technical burnout, and physiological arousal, while emotional support exclusively affected technical burnout. These empirical studies contribute valuable insights into the multifaceted relationships between educational technology, social support, academic engagement, and well-being among diverse student populations.

Based on prior research, this study sought to enhance current knowledge by examining how technology-related anxiety mediates and moderates the relationship between social support and learner engagement.

Method

The research adopted a quantitative and survey-correlation methodology, as it was necessary to analyze multiple variables within a complex process and study each of them separately.

Participants

The study encompassed the entire student population of Famenin City within Hamadan province, totaling 528 individuals (N=528). The research participants were selected using a random cluster sampling method, leading to a final sample size of 402 students (n=402), including 221 females and 181 males. The sampling process unfolded as follows: Initially, eight secondary schools, equally divided between male and female schools, were randomly chosen from the complete pool of second secondary schools, utilizing a random cluster sampling approach. Subsequently, in the following phase, three classes were randomly selected from each of the chosen schools.

The details of the participants are shown in Table 1.

The above table shows that 402 eighth-grade students of Famenin City participated in this research, 45% boys and 55% girls. Also, as seen in Table 1, most of the students are 14 years old, with a frequency of 71.1%, and 28.1% are 13 years old. On the other hand, 0.7% of the students did not answer the question correctly.

Instruments

Academic Engagement Questionnaire

The Academic Engagement Questionnaire by Rio was utilized to assess students' academic engagement. This questionnaire consists of 17 items and four subscales, namely causal, behavioral, cognitive, and emotional engagement, gauging the level of student engagement in academic matters.

Table 1: Characteristics of the participants

		Frequency	Percentage	Cumulative percentage
Age	13	113	28.1	28.1
	14	286	71.1	100
	No response	3	0.7	-
	Total	402		-
Gender	Male	181	45	
	Female	221	55	
	Total	402	100	

Participants responded on a seven-point Likert scale, ranging from completely disagree (1) to completely agree (7). Ramezani and Khamsan [44] examined the psychometric properties of the questionnaire in an Iranian context, reporting good construct validity and reliability using Cronbach's alpha for the entire questionnaire (α = 0.92) and its behavioral (α = 0.79), cognitive (α = 0.79), emotional (α = 0.87), and causal (α = 0.85) subscales.

Social Support Questionnaire

The CASSS2000 questionnaire developed by Maleki and Dimari [45] was employed to measure social support. This questionnaire comprises 60 items, assessing social support received from five sources: parents, teachers, classmates, close friends, and school parents. Each source's social support is measured using 12 items, encompassing four types of support: emotional, informational, evaluative, and instrumental. The scale was validated for the Iranian context by Khamsan and Abutalebi [46], with Cronbach's alpha calculated for each subscale. The obtained coefficients for the amount and importance of support in each subscale were as follows: parents (α = 0.89 and 0.81, respectively), teachers (α = 0.88 and 0.87, respectively), close friends (α = 0.90 and 0.86, respectively), classmates (α = 0.91 and 0.88, respectively), and other people (α = 0.93 and 0.92, respectively). Its validity was determined through factor analysis, which supported its construct validity.

Technology Anxiety Questionnaire

Bandalos and Benson's [47] computer anxiety scale, consisting of 23 items designed on a six-point scale (1 completely disagree to 6 completely agree), was adopted to measure technology anxiety. This scale assesses users' anxiety towards computers and can be reduced to three factors: communication with the computer (8 items), success in working with the computer (13 items), and trust and intimacy with the computer (9 items). The scale demonstrated high reliability with Cronbach's alpha values of 0.90, 0.90, 0.93, and 0.96 in a study with 375 subjects. Zaki [48] validated this questionnaire for the Iranian context, with modifications made in the current research to encompass technology anxiety. Alterations were made to the items, incorporating the words ‘computer, mobile, and tablet’ instead of solely "computer." to address the overlap between technology anxiety and computer anxiety.

Data Analysis

The data analysis method utilized a combination of descriptive and inferential statistics. Descriptive statistics involved calculating frequency, percentage, mean, and standard deviation, while inferential statistics included structural equation modeling and Spearman correlation. The Partial Least Squares (PLS, Version 4) software was employed for calculations and statistical analysis.

Ethics

Ethical approval was obtained to ensure the participation of these individuals in the study. Informed consent was obtained from all participants, signifying their voluntary agreement to be part of the research project. Furthermore, participants were assured that their personal information would be treated with strict confidentiality.

Results and Findings

Participants’ Accessibility to Technology

Table 2 shows the frequency distribution of participants according to access to the type of technology. Based on the data presented in Table 2, the results indicate that the highest

frequency, accounting for 89.3% of the participants, corresponds to mobile access, signifying that most students possess mobile phones. Conversely, the lowest percentage of 3.5% is associated with students who lack access to any of the mentioned devices. Furthermore, the frequency of tablet access is 13.9%, suggesting that tablets are the least utilized among the student population. These results provide valuable insights into students' technological device preferences and usage patterns within the educational context.

Table 2: Frequency distribution of students based on the type of available technology

Technology Type in the access		Percentage	Frequency
Computer	Yes	22.6	91
	No	77.4	311
	Total	100	402
Mobile phone	Yes	89.3	359
	No	10.7	43
	Total	100	402
Tablet	Yes	13.9	56
	No	86.1	346
	Total	100	402
Laptop	Yes	14.4	58
	No	85.6	344
	Total	100	402
All of them	Yes	3.5	14
	No	96.5	388
	Total	100	402

Table 3 presents the findings, revealing that the social support variable exhibits the highest mean value, standing at 4.46. In contrast, the variable indicating technology anxiety records the lowest mean, with a value of 3.04. Furthermore, the mean score for student academic engagement stands at 4.44. Notably, social support and learner academic engagement variables display the lowest and highest levels of score dispersion, respectively.

Table 3: Central indices and dispersion of variables of social support, learner's academic engagement, and technology anxiety

Research variables	Mean	SD	Variances
Social support	1.858	1.363	4.46
Learner's academic engagement	3.055	1.747	4.44
Technology anxiety	2.322	1.523	3.04

In order to standardize the questions across the research dimensions, a confirmatory factor analysis test was employed. The results of this analysis, specifically the factor loadings for each questionnaire item, are presented in Table 4.

Table 4 displays the examination of factor loadings, with questions having factor loadings exceeding 0.7 retained in the external measurement model and validated. Conversely, questions with factor loadings below 0.7 are excluded from the final model. The research question is analyzed based on this finalized model. Notably, all research variables exhibit factor loadings exceeding 0.7, resulting in the retention of all questions in the measurement model.

Validity and Reliability

In terms of assessing convergent validity, the study also employed the Average Variance Extracted (AVE) test. The outcomes of this evaluation are presented in Table 5.

Table 4: Factor Loadings of Questions in the Research Measurement Model

Variable	Dimension	Question	Factor loading	Result	Variable	Dimension	Question	Factor loading	Result
Social Support	Social support of parents	1	.937	Confirmed	Learners Academic Engagement	Affective Engagement	1	.837	Confirmed
		2	.914	Confirmed			2	.787	Confirmed
		3	.933	Confirmed			3	.845	Confirmed
		4	.927	Confirmed			4	.841	Confirmed
		5	.928	Confirmed		Behavioral Engagement	5	.79	Confirmed
		6	.95	Confirmed			6	.853	Confirmed
		7	.931	Confirmed			7	.837	Confirmed
		8	.898	Confirmed			8	.816	Confirmed
		9	.853	Confirmed			9	.768	Confirmed
		10	.896	Confirmed			10	.77	Confirmed
		11	.942	Confirmed			11	.825	Confirmed
		12	.883	Confirmed		Cognitive Engagement	12	.88	Confirmed
	Social support of teachers	13	.911	Confirmed			13	.868	Confirmed
		14	.931	Confirmed			14	.845	Confirmed
		15	.899	Confirmed			15	.882	Confirmed
		16	.914	Confirmed			16	.839	Confirmed
		17	.91	Confirmed			17	.709	Confirmed
		18	.707	Confirmed	Technology anxiety	Contact with Technology	1	.891	Confirmed
		19	.746	Confirmed			2	.899	Confirmed
		20	.884	Confirmed			3	.882	Confirmed
		21	.727	Confirmed			4	.898	Confirmed
		22	.913	Confirmed			5	.871	Confirmed
		23	.734	Confirmed			6	.809	Confirmed
		24	.736	Confirmed			7	.889	Confirmed
		25	.764	Confirmed			8	.856	Confirmed
	Social support of classmates	26	.908	Confirmed		Success in working with technology	9	.9	Confirmed
		27	739	Confirmed			10	.865	Confirmed
		28	.94	Confirmed			11	.851	Confirmed
		29	.947	Confirmed			12	.805	Confirmed
		30	.93	Confirmed			13	.828	Confirmed
		31	.918	Confirmed			14	.777	Confirmed
		32	.921	Confirmed			15	.77	Confirmed
		33	.924	Confirmed			16	.858	Confirmed
		34	.907	Confirmed			17	.772	Confirmed
		35	.928	Confirmed			18	.867	Confirmed
		36	.868	Confirmed		Trust and Intimacy with Technology	19	.923	Confirmed
							20	.909	Confirmed
							21	.878	Confirmed
							22		Confirmed
							23		Confirmed

Table 5: Evaluation of Convergent Validity in the Measurement Model

Variable	AVE
Contact with technology	.766
Technology anxiety	.62
Trust and Intimacy with Technology	.726
social support	.612
Social support of teachers	.561

Variable	AVE
Social support of classmates	.728
Social support of parents	.841
Learners' Academic Engagement	.557
Behavioral conflict	.674
Cognitive conflict	.700
Emotional conflict	.614
Causal conflict	.686
Success in working with technology	.667

It is clear, the AEV was greater than 0.5 for all variables. Therefore, the convergence validity of the measurement model is confirmed. The results of divergent validity using the Fornell and Larcker test are also given in Table 6.

Based on Table 6, it can be said that the values on the main diameter, which are the root mean of the extracted variance, are more than the numbers of each row. Therefore, there is divergent validity between the variables. The reliability of the measurement model was measured based on Cronbach's alpha test, Composite reliability test, and Spearman test (according to Table 7).

Table 6: Investigating divergent validity in the research measurement model

	1 Contact with technology	2 Technology anxiety	3 Trust and intimacy with technology	4 social support	5 Social support of teachers	6 Social support of classmates	7 Social support of parents	8 Learners' Academic Engagement	9 Behavioral Engagement	10 Cognitive Engagement	11 Emotional Engagement	12 Agentive Engagement	13 Success in working with technology
1	.875												
2	.747	.787											
3	.735	.733	.852										
4	.725	.774	.661	.782									
5	.651	.691	.623	.715	.749								
6	.638	.683	.602	.827	.802	.854							
7	.717	.768	.625	.850	.811	.799	.917						
8	.712	.743	.607	.725	.623	.639	.733	.746					
9	.665	.700	.545	.685	.569	.598	.707	.738	.821				
10	.623	.648	.543	.629	.542	.555	.635	.81	.800	.837			
11	.638	.651	.527	.616	.547	.551	.605	.781	.769	.757	.784		
12	.666	.705	.599	.706	.614	.618	.713	.809	.809	.772	.728	.828	
13	.762	.756	.769	.755	.648	.655	.772	.726	.707	.621	.625	.683	.817

Table 7: Reliability check of the measurement model

Variable	Cronbach's alpha	Spearman test	Composite reliability test
Contact with technology	.956	.957	.963
Technology anxiety	.972	.973	.974
Trust and Intimacy with Technology	.940	.931	.922
social support	.981	.988	.977
Social support of teachers	.932	.972	.926
Social support of classmates	.968	.982	.961
Social support of parents	.984	.983	.983
Learners' Academic Engagement	.955	.953	.949
Behavioral conflict	.912	.88	.878
Cognitive conflict	.903	.861	.856
Emotional conflict	.860	.827	.778
Causal conflict	.897	.850	.847
Success in working with technology	.947	.942	.937

The quality of the measurement model using the Commuality Cros Vality (CV com) test of the shared index is given in Table 8.

Table 8: The quality of the research measurement model

Variable	Model	Result
social support	.557	Very strong
Learners' Academic Engagement	.475	Very strong
Technology anxiety	.555	Very strong

Each variable was assessed using three different values: 0.02 (indicating a weak measurement model quality), 0.15 (indicating a medium measurement model quality), and 0.35 (indicating a strong measurement model quality). The results indicated that the measurement models for the social support variables, learner's academic engagement, and technology anxiety exhibited a very strong level of quality.

Q 1. To what extent does technology anxiety mediate the relationship between social support and the academic engagement levels of learners?

The results of the structural equation analysis are presented in Table 9, examining the relationship between social support and the learner's degree of academic engagement, considering the mediating role of technology anxiety. It offers valuable insights into the complex interplay among these variables, shedding light on the potential impact of social support and technology anxiety on academic engagement within the context of educational technology.

Based on the data presented in Table 9, the t-values for the relationships under examination fall outside the range of 2.58 and -2.58, indicating that these relationships are statistically significant at a 99% confidence level. The beta coefficients reveal that social support has a direct positive effect of 37% on the learner's academic engagement. Furthermore, social support directly influences technology anxiety by 77%, and technology anxiety, in turn, negatively impacts the learner's academic engagement by 45%. Additionally, social support indirectly affects the learner's academic engagement by mediating technology anxiety, accounting for 17% of the total effect. Overall, the learner's academic engagement is simultaneously affected by social support directly and indirectly, representing a total effect of 54%, indicating that technology anxiety partially mediates. Consequently, it can be deduced that social support is significantly related to the learner's academic engagement, and this relationship is mediated by technology anxiety.

Furthermore, the Sobel test was employed to examine the mediating role of the technology anxiety variable. This test uses normal estimation to determine the significance of the relationship, testing the null hypothesis against the alternative hypothesis based on the estimate of the standard error of the indirect effect. The Z value obtained from the Sobel test is 8.09, with a standard deviation of 0.043, and the significance level is 0.001, which is less than 0.05. Consequently, at a confidence level of 95%, technology anxiety acts as a mediating variable between social support and the learner's academic engagement. Subsequently, the predictive power of the learner's academic engagement is assessed, and Table 10 examines its predictive capacity within the context of the first research question.

Table 9: The relationship between social support and learners' academic engagement with the mediating role of technology anxiety

Relationship	Path coefficient (beta)			SD	t-value	Sig	Result
	Direct effect	indirect effect	total effect				
social support on academic engagement	0.374	0.169	0.543	0.054	6.952	0.001	significant
social support on technology anxiety	0.774	-	-0.774	0.026	29.42	0.001	significant
technology anxiety on academic engagement	-0.454	-	-0.454	0.054	8.356	0.001	significant

Table 10: The predictive power of the criterion variable in the first research question

Predictor/Criteria variable	Learners' academic engagement							
	Adjusted R2	Result	F2	Result	Gof	Result	Stone & Geisser index Q2	Result
Social support Technology anxiety	0.607	Strong	0.143 0.211	Moderate Very strong	0.58	Very strong	0.315	Strong

Table 10 presents the adjusted R2 index values for the criterion or endogenous variable, with scores indicating weak (0.19), moderate (0.33), and strong (0.67) prediction quality. The combined effect of social support and technology anxiety strongly predicts the learner's academic engagement, accounting for 61% of the variance in the endogenous variable. The f2 index assesses the contribution of each predictor variable in R2, with values representing weak (0.02), moderate (0.15), and strong (0.35) prediction quality. From this index, it can be inferred that social support and technology anxiety have moderate and strong contributions, respectively, to the adjusted R2, with technology anxiety making a more significant impact. The Gof test, evaluating the goodness of fit index, yields a value of 0.58, surpassing the standard values of weak (0.01), moderate (0.26), and strong (0.36) quality measurement. This indicates a very strong fit of the model in testing the primary research question. Additionally, the Stone-Geisser index Q2 for the endogenous variable is 0.31, demonstrating a strong quality of the structural model concerning the first research question. As a result, the conceptual model of the research exhibits a favorable fit. The measurement model of the research, including coefficient estimation and significance, is provided in Figs. 1 and 2.

Q 2. To what degree is there a statistically significant relationship between the social support provided by teachers and the academic engagement levels exhibited by students?

To check the second question, Spearman's non-parametric correlation tests were used. Table 11 shows the correlation coefficient and significance level between the two variables of students' academic engagement and teachers' social support.

Table 11: Correlation coefficients between students' academic engagement and teachers' social support

Predictor/Criteria variable	teachers' social support	
	Correlation coefficient	Sig
students' academic engagement	0.491**	0.001

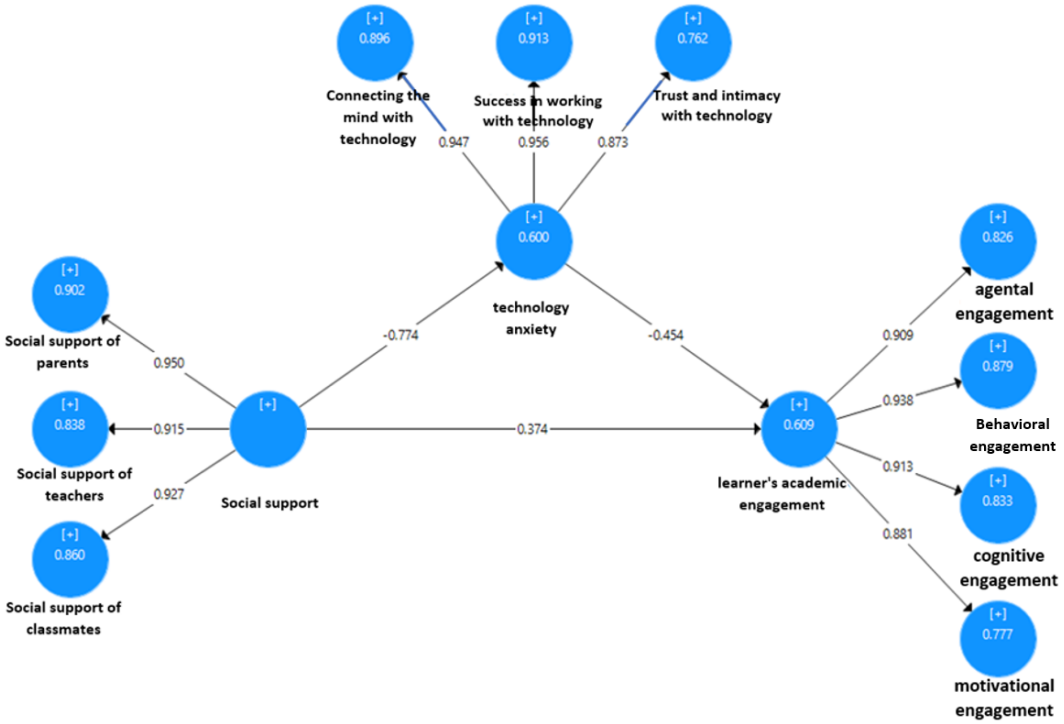

Fig. 1: Research measurement model in coefficient estimation mode

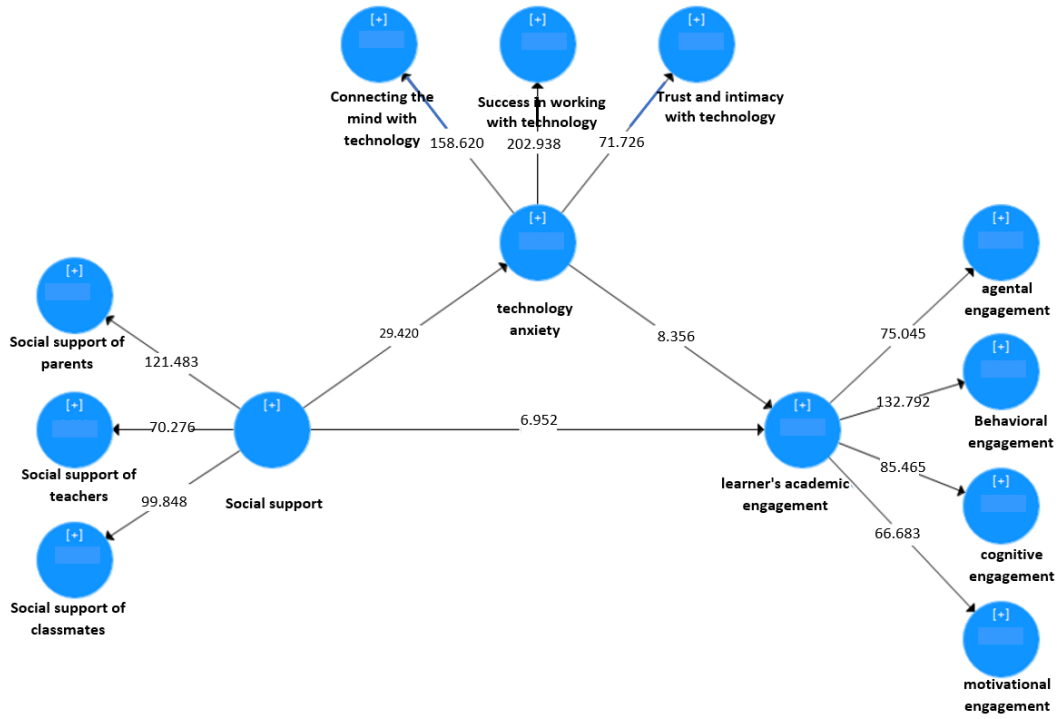

Fig. 2: Research measurement model in the significance mode of coefficients

Based on the results presented in Table 11, a significant positive relationship is observed between students' academic engagement and teachers' social support, with a confidence level of 99%. The findings suggest that as students' academic engagement increases, there is a corresponding increase in the level of social support provided by teachers. The positive correlation coefficient further supports the direct relationship between these two

variables. Consequently, it can be concluded that students' academic engagement is indeed associated with the level of social support received from teachers.

Q 3. To what extent is a statistically significant relationship between parental social support and students' academic engagement levels?

Spearman's non-parametric correlation tests were employed to explore the third research question. The correlation coefficient and significance level between students' academic engagement and parents' social support are presented in Table 12. The analysis aims to determine the strength and direction of the relationship between these two variables within the context of educational technology.

Table 12: Correlation coefficients between students' academic engagement and parents' social support

Table		
Predictor/Criteria variable	Parents' social support	
	Correlation coefficient	Sig
Students' academic engagement	0.595**	0.001

According to the findings presented in Table 12, a significant relationship exists between students' academic engagement and the social support provided by parents, with a confidence level of 99%. It implies that as the student's academic engagement increases, parents' social support also increases. The positive correlation coefficient signifies a direct association between these variables, indicating that the academic engagement of the learner is positively linked to the level of social support offered by parents.

Q 4. To what degree is there a statistically significant relationship between the social support received from classmates and the academic engagement levels demonstrated by students?

The fourth question was examined using Spearman's non-parametric correlation tests. Table 13 displays the correlation coefficient and significance level between the learner's academic engagement and the social support provided by classmates.

Table 13: Correlation coefficients between students' academic engagement and classmate's social support

Predictor/Criteria variable	The social support of classmate	
	Correlation coefficient	Sig
Students' academic engagement	0.533**	0.001

Based on the findings presented in Table 13, there is a significant relationship between the learner's academic engagement and the social support received from classmates, with a confidence level of 99%. It implies that as the student's academic engagement increases, so does the social support provided by classmates. The positive correlation coefficient indicates a direct association between these two variables, confirming that the learner's academic engagement is indeed connected to the social support received from classmates. The investigation of this question was conducted using Spearman's non-parametric correlation tests, and the results are illustrated in Table 13, where the correlation coefficient and significance level between the learner's academic engagement and the social support offered by classmates are presented.

Q 5. To what extent does technology anxiety act as a moderating factor in the relationship between social support and the academic engagement levels of learners?

Structural equation analysis using PLS software was employed to examine the fifth research question. The results of the significance test for the fifth research question are presented in Table 14.

Based on the findings presented in Table 14, the t-values associated with these relationships exceed the critical thresholds of 2.58 and -2.58. This outcome demonstrates that the relationships are statistically significant at a 99% confidence level. Furthermore, it was observed that technology anxiety plays a moderating role, accounting for a 9% variation in the relationship between social support and student academic engagement. This result supports the anticipation that the fifth research question will gain further validation with a larger sample drawn from the same population. Subsequently, Table 15 evaluates the predictive capacity of student academic engagement within the context of the fifth research question.

Table 15 provides insights into the predictive quality of the endogenous variable, as indicated by the adjusted R2 index. This metric is measured on a scale with values of 0.19 (reflecting weak predictive quality), 0.33 (suggesting moderate predictive quality), and 0.67 (indicating strong predictive quality). In the case of the endogenous variable, which is the learner's academic engagement and the central focus of the research question, it was found to be strongly predicted with an explanatory power of 41%. Furthermore, the CV Red index assessed the structural model quality for the endogenous variable. The index also follows a scale featuring values of 0.02 (representing poor structural model quality), 0.15 (indicating moderate structural model quality), and 0.35 (reflecting strong structural model quality). In this instance, the learner's academic engagement variable achieved a CV Red value of 32%, signifying a robust structural model quality within the context of the fifth research question.

Table 14: The relationship between social support and the learner's academic engagement with the moderating role of technology anxiety

Relationship	Path coefficient (beta)	SD	t-value	Sig	Result
Social support on academic engagement	0.313	0.055	5.679	0.001	significant
Technology anxiety on academic engagement	-0.433	0.057	67.4	0.001	significant
Social support * technology anxiety on academic engagement	-0.094	0.028	3.419	0.001	significant

Table 15: Predictive power of the criterion variable in the fifth hypothesis of the research

Endogenous variable	Adjusted R2	Result	CV Red	Result
Learner’s academic engagement	0.317	Strong	0.613	Strong

Discussion

This research explored the relationship between social support and learners' academic engagement level, considering the mediating role of technology anxiety. The study hypothesized that social support would have a significant association with the level of academic engagement, with technology anxiety acting as a mediating factor. The analysis results indicated that the proposed model was acceptable, and all direct and indirect paths within the model were found to be significant. The findings pertaining to the research question are discussed and explained below.

The outcomes of the present study align with previous research by Weinert et al. [40], Lee et al. [42], and Salas et al. [41], which also emphasized the association between social support, academic engagement, and technology anxiety. This alignment can be attributed to the notion that reducing technology anxiety involves addressing behavioral, psychological, and physiological associated responses [49]. Social support plays a crucial role in influencing these responses, as users seek instrumental support to cope with stressful situations and emotional support to regulate negative emotions linked to technology-related stress [40]. Parents and teachers contribute to diminishing technology anxiety by providing tangible help, such as mobile phones, computers, and tablets, which enhances students' access to technology and alleviates anxiety. Additionally, educators and peers can impart essential knowledge and information to students, enabling them to use technology more proficiently. By fostering trust and reliance on teachers, parents, and classmates, students feel comfortable discussing their technological concerns and receive the emotional validation and assistance they need. Offering feedback and guidance during technology use further reduces anxiety and enables deeper, more engaged learning experiences. Engaging in activities through educational technologies can heighten academic engagement, as various studies have demonstrated that technology can positively impact student engagement [e.g.,30-31].

The findings of this study also support the relationship between academic engagement and teachers' social support, aligning with prior research by Reeve et al. [50], Engels et al [2]., Wang and Eccles [4], Nouwen et al. [19], Azadi Dehbidi and Fouladchang [51], Hejazi et al. [52], Ramazani et al. [53], Hassannia and Sabzi [54], Rezaa'ee Varmazyaar et al. [55], and Moltafet et al. [56]. Because teachers, through their provision of social support, address the intrinsic psychological needs of students- such as competence, autonomy, and relatedness- facilitating and accelerating academic engagement in learning tasks. By meeting these fundamental needs, teachers enhance students' motivation and focus on classroom activities. Allowing students autonomy in their learning tasks and connecting school activities to their personal interests and goals fosters a sense of self-worth and a genuine interest in learning [57]. Establishing supportive and close relationships also leads students to internalize teachers' objectives, values, motivation, and learning strategies, consequently improving students' self-efficacy and increasing their engagement in the learning process [58].

The findings of the current study revealed a significant relationship between academic engagement and parental social support, corroborating the results of prior research by Wilcox et al. [59], Wang and Eccles [4], Nouwen et al. [19], Ursin et al. [19], Gutiérrez et al. [60], Pan et al. [58], Rezaa'ee Varmazyaar et al. [55], and Taghavi and Ekhtiari [61]. It can be noted

that a considerable portion of academic engagement is inherently social and emotional to explain this finding. Thus, a strong emphasis on fostering home-schools relationships and enhancing student-learning connections is vital for effective interventions [59]. Students who receive support from their parents' experience increased feelings of competence, control, and value toward education [19]. This parental assistance encompasses aiding in challenging assignments, providing guidance, encouragement, and rewards, and fostering a sense of student responsibility, ultimately leading to heightened engagement and academic progress.

Furthermore, the study's results demonstrated a positive correlation between academic engagement and peer/classmates' social support, aligning with previous studies by Wilcox et al. [59], Elsaesser et al. [62], Ansong et al. [63], Ursin et al. [18], Kiefer et al. [64], Pan et al. [58], Rabbani et al. [65], Azadi Dehbidi and Fouladchang [51], Hassannia and Sabzi [54], Rezaa'ee Varmazyaar et al. [55], and Taghavi and Akhtiari [61]. Peer and classmate support play a crucial role during adolescence, as it fulfills the teenagers' need for social connection and contributes to their satisfaction in the school environment [4]. The accessibility of supportive classmates who lend a listening ear and offer problem-solving assistance directly impacts academic engagement [63]. Moreover, implementing comprehensive and targeted support at the school and class levels can fortify positive academic attitudes and enhance engagement in the teaching and learning processes. Classmates who perceive the significance of education and support their peers' academic success act as important protective factors, influencing positive attitudes toward education and active participation in the learning process [19].

Conclusions

The primary aim of our study is to examine the intricate relationships among different aspects of social support, academic engagement, and the roles of technology anxiety, serving as both a mediator and a moderator. Specifically, our research is situated within the unique context of the COVID-19 pandemic, focusing on adolescents aged 13 and 14 in Famenin City, Hamadan province. Our investigation stems from the desire to gain insights into how these adolescents engaged with various technologies—from mobile phones and computers to laptops and tablets—to participate in virtual educational experiences during the challenging pandemic actively. Our compelling conclusion, drawn from a meticulous analysis of extensive descriptive data, underscores that a well-designed approach to instructional materials, with a notable emphasis on mobile phone compatibility, could offer substantial advantages. This assertion is firmly supported by the widespread prevalence of mobile phone access among our target demographic (89.3%), establishing them as a critical channel for delivering educational content in these exceptional circumstances. Consequently, recognizing adolescents' accessibility to technology for learning and aligning the virtual educational system accordingly is deemed indispensable.

The study's results exposed a nuanced relationship involving social support, technology anxiety, and the academic engagement of learners. Significantly, technology anxiety emerged as a key mediator in this intricate framework. It was observed that social support had a direct impact on technology anxiety, accounting for a substantial 77% of the variance. Simultaneously, technology anxiety played an indirect and

inhibiting role in diminishing learners' academic engagement. Consequently, a heightened level of access to diverse forms of social support was associated with reduced technology anxiety—a noteworthy observation in the context of virtual education. An intriguing aspect of the research involved the breakdown of social support based on its sources—teachers, parents, and classmates. The findings underscored the constructive contributions of all three sources of social support to the enhancement of academic engagement within the realm of virtual education. Furthermore, the study delved into another layer of relationship dynamics, revealing that technology anxiety moderates the interplay between social support and academic engagement. While the magnitude of this moderating effect may not have been as pronounced as the mediating role of technology anxiety, it retained both practical and statistical significance within the study's context. The direct influence of social support on technology anxiety, explaining a substantial 77% of the variance, is a noteworthy outcome. The study's findings highlight the significant impact of social support on technology anxiety within the realm of virtual education. So, adequate social support contributes to a reduction in technology anxiety, creating a more conducive environment for learning. The thorough analysis of inferential data substantiates this assertion, emphasizing the pivotal role of social support in alleviating technology-related anxieties.

In light of these insightful findings, it is imperative for policymakers, decision-makers, instructional designers, and educators engaged in the realm of virtual education to underscore the paramount importance of diverse forms of social support. Such emphasis holds the potential to substantially augment academic engagement and alleviate technology anxiety among adolescents aged 13 and 14. Through the judicious provision of adequate social support, learners may witness reduced technology-related anxieties, culminating in heightened participation in virtual education. It, in turn, promises to yield a more productive and gratifying learning experience, especially during difficult periods such as the COVID-19 pandemic. However, it is essential to acknowledge the inherent limitations of this study. The cross-section research accentuates the necessity for longitudinal investigations in this domain. Furthermore, the reliance on self-reported student data necessitates contemplating alternative data collection methods in subsequent studies.

Authors' Contribution

All authors have contributed equally to the execution and composition of this article.

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Conflicts of Interest

In this study, the authors declare no conflicts of interest.

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AUTHOR(S) BIOSKETCHES

Mostafa NOOROLAHEI completed his Master's in Educational Technology at Bu-Ali Sina University. His research pursuits encompass e-learning, mobile learning, emerging educational technologies, and the implementation of gamification. He possesses six years of experience as an educator within the educational system of Hamadan province.

Noorolahei M, MA Educational Technology, Faculty of Human Sciences, Bu-Ali Sina University, Hamedan, Iran

m.norollahi.73@gmail.com

Hossein ZANGENEH has been an Assistant Professor in Educational Technology at Bu-Ali Sina University since 2013, obtaining a Ph.D. in Educational Technology from Allameh Tabataba'i University. His expertise spans instructional design and development research, the development of learning technology, and digital content. Over 11 years, he has been an educational consultant and designer for various organizations, contributing to over 100 projects. He boasts an extensive literary portfolio, having authored and translated over 11 books and penned 31 articles. Additionally, he has lent his expertise as a keynote speaker at conferences and has conducted numerous instructional workshops.

Zangeneh, H., Assistant Professor, Educational Technology, Faculty of Human Sciences, Bu-Ali Sina University, Hamedan, Iran

Zangeneh@basu.ac.ir

Maryam POURJAMSHIDI holds a doctoral degree in Educational Technology from Allameh Tabataba'i University and is an Associate Professor in the Educational Technology department within the Faculty of Education Sciences. Since 2005, she has been actively engaged in teaching and research as a faculty member at Bu-Ali Sina University. Her contributions encompass many publications, including books, articles, and research proposals focused on education and learning.

Pourjamshidi M. PhD, Educational Technology, Faculty of Human Sciences, Bu-Ali Sina University, Hamedan, Iran

m.pourjamshidi@basu.ac.ir

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ORIGINAL RESEARCH PAPER

Developing E-learning Materials Based on Cognitive Load Theory to Improve Students' Learning Levels in Online Physics Education

***Z. Rahbar*[1], *F.Ahmadi* [*1], *M.Saidi*[2]**

[1] *Department of Physics, Shahid Rajaee Teacher Training University, Tehran, Iran*
[2] *Department of English, Shahid Rajaee Teacher Training University, Tehran, Iran*

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* Corresponding author
fahmadi@ sru.ac.ir
(+98912) 5865389

ABSTRACT

Background and Objectives: The emergence of COVID-19 has brought about a sudden shift to e-learning and virtual platforms. Teachers play a key role in developing e-learning content. Hence, they must be familiar with the theories related to the cognitive constructs and e-learning principles to both facilitate the learning process and enhance the rate of learning and retention among the students. The cognitive load might increase unless the e-learning and experiential content is not developed according to the cognitive load theory, particularly for teaching physics as a field that requires multimodal presentation of the content. This might hinder the students' learning and retention. In other words, if the principles of cognitive load theory are not observed in the design of electronic and multimedia content of course materials, the learning process will be disturbed and damaged due to the production of additional load beyond the memory capacity of the learners. The current study aimed to develop e-learning content for a concept in physics (e.g. pressure) based on the cognitive load theory. It further attempted to explore its possible impact on the learners' levels of learning (knowledge, understanding, application) and the degree of their retention.

Materials and Methods: The study adopted a quasi-experimental pre-test post-test design with an experimental and a control group. The statistical population included all female ninth graders in district 17, Tehran, the capital of Iran. The sample consisted of 120 learners via multistage stratified random sampling procedures. The participants were assigned to experimental and control groups. To gather the required data, a researcher-made test was used and its reliability was calculated via Cronbach's alpha as 0.85. The students took part in a three-week virtual empirical sciences course comprising six sixty-minute sessions. Before offering the course, the educational objectives of chapter 8 of the empirical sciences textbook in the ninth grade related to the subject "pressure" were determined using the teacher's manual and eliciting the experienced sciences and physics teachers' expert comments. Then, their level of cognitive processing was identified based on Bloom's taxonomy. The objectives were categorized into three groups of knowledge, understanding, and application. To analyze the data, analysis of covariance and an independent samples t-test were used via SPSS (20.00).

Findings: The results of the analysis of covariance for learning levels (knowledge, understanding, and application) demonstrated that developing e-learning materials based on the cognitive load theory enhanced the learners' levels of learning in the experimental group compared to those in the control group ($P < 0.05$). Moreover, the results of an independent samples t-test for the delayed post-test revealed a significant difference between the participants in experimental and control groups in terms of their degree of retention ($P < 0.01$).

Conclusions: The findings implied that considering the principles of the cognitive load theory in developing e-learning materials for physics would positively influence the learners' levels of learning and their degree of retention. Therefore, it is recommended to designers of e-learning content to consider the principles of cognitive load theory in the design and production of their content.

NUMBER OF REFERENCES	NUMBER OF FIGURES	NUMBER OF TABLES
37	2	6

مقاله پژوهشی

توسعه مواد آموزش الکترونیکی بر اساس تئوری بار شناختی برای بهبود سطوح یادگیری دانش‌آموزان در آموزش آنلاین فیزیک

زهرا راه بر[1]، فاطمه احمدی*[،1]، مودت سعیدی[2]

[1] گروه فیزیک، دانشکده علوم پایه، دانشگاه تربیت دبیر شهید رجائی، تهران، ایران
[2] گروه زبان انگلیسی، دانشکده علوم انسانی، دانشگاه تربیت دبیر شهید رجائی، تهران، ایران

چکیده

پیشینه و اهداف: امروزه به دلایل مختلفی از جمله ظهور بیماری کرونا، شاهد استقبال نظام های آموزشی از آموزش های غیرحضوری هستیم. در این زمان، نقش اصلی در طراحی آموزشی دوره های آموزش غیرحضوری را معلمان هر درس برعهده دارند؛ بنابراین آن ها باید با نظریه های مربوط به ساختار شناختی و چگونگی یادگیری دانش آموزان از محتواهای الکترونیکی آشنا باشند تا آموزش های آن ها ضمن تسهیل فرآیند یادگیری، سبب بالا بردن سطوح یادگیری و افزایش میزان یادداری مطالب آموزشی در دانش آموزان نیز شود. زیرا چنانچه محتواهای الکترونیکی و چندرسانه ای طراحی شده به خصوص در درسی مانند فیزیک که از انواع رسانه ها و بازنمایی های متعدد برای انتقال مفاهیم بهره می گیرد طبق اصولی سازگار با ساختار شناختی یادگیرندگان طراحی نشود، ممکن است باعث واردآمدن بارشناختی اضافه به حافظه ی یادگیرندگان شود و این امر مانعی برای فرآیند یادگیری و یادداری مطلب در یادگیرندگان باشد. لذا پژوهش حاضر باهدف طراحی یک محتوای الکترونیکی برای درس فیزیک (مثلاً مبحث فشار) بر اساس اصول نظریه بارشناختی و بررسی تأثیر آن بر سطوح یادگیری (دانش، فهمیدن و به‌کاربستن) و میزان یادداری دانش‌آموزان از مبحث آموزشی انجام شد.

روش‌ها: روش پژوهش نیمه‌آزمایشی از نوع طرح پیش‌آزمون - پس‌آزمون با گروه کنترل بود. جامعه آماری پژوهش، شامل کلیه دانش‌آموزان دختر پایه نهم دوره متوسطه اول مدارس عادی آموزش‌وپرورش ناحیه ۱۷ استان تهران است که در سال ۱۴۰۱-۱۴۰۰ مشغول به تحصیل بودند. نمونه‌گیری از نوع تصادفی خوشه‌ای چندمرحله‌ای و تخصیص تصادفی در گروه‌های آزمایش و کنترل انجام‌گرفته است. حجم نمونه آماری تحقیق ۱۲۰ نفر است که در دو گروه همسان آزمایش و کنترل قرار گرفتند. برای جمع‌آوری داده‌های سطوح یادگیری و میزان یادداری از یک آزمون پیشرفت تحصیلی محقق ساخته به صورت پیش‌آزمون-پس‌آزمون استفاده شد که روایی صوری و محتوایی آن توسط دبیران با تجربه علوم‌تجربی و اساتید آموزش فیزیک تایید و پایایی آن به روش آلفای‌کرونباخ ۰/۸۵ سنجیده شده بود. اجرای دورهٔ آموزشی این پژوهش به‌صورت مجازی و در بستر سامانه شاد (شبکه اجتماعی دانش‌آموزی) در طی ۳ هفته آموزشی، ۶ جلسهٔ ۶۰ دقیقه‌ای در کلاس‌های مجازی علوم‌تجربی پایه نهم انجام‌گرفته است. قبل از شروع دورهٔ آموزشی، ابتدا طرح درس‌ها و محتوای آموزشی مربوط به یک مبحث از فیزیک (مبحث فشار و آثار آن) برای گروه کنترل به شیوه کلاس‌های مجازی متداول تهیه و تدوین شدند و سپس با مطالعه دقیق مبانی نظری و تجربی نظریه بارشناختی، طرح درس‌ها و محتواها با رعایت اصول نظریه بار شناختی برای گروه آزمایش تهیه و تدوین گردید. به منظور تجزیه و تحلیل داده ها از نرم افزار SPSS 20 استفاده شد.

یافته‌ها: نتایج آزمون تحلیل کوواریانس برای سطوح یادگیری نشان داد، طراحی محتوای الکترونیکی مبتنی بر نظریه بارشناختی، سبب ارتقای بیشتر سطوح یادگیری(دانش، به فهمیدن و به کاربستن) دانش‌آموزان گروه آزمایش نسبت به گروه کنترل می‌شود($p < ۰/۰۵$). همچنین نتیجه آزمون تی مستقل برای آزمون یادداری نشان می‌دهد، بین گروه کنترل و آزمایش در میزان یادداری آن‌ها از مبحث تدریس شده تفاوت معناداری وجود دارد($p < ۰/۰۱$).

نتیجه‌گیری: باتوجه‌به نتایج به‌دست‌آمده از مطالعه حاضر می‌توان نتیجه‌گیری کرد که رعایت اصول طراحی آموزشی مبتنی بر نظریه بارشناختی در تولید محتوای آموزشی الکترونیکی درس فیزیک، تأثیر مثبت قابل‌توجهی بر روی سطوح یادگیری و میزان یادداری دانش‌آموزان از مباحث آموزشی دارد. لذا به طراحان محتواهای آموزش الکترونیکی توصیه می‌شود تا اصول نظریه ی بارشناختی را در طراحی و تولید محتوا های خود مدنظر قرار دهند.

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سطوح یادگیری
یادداری

* نویسنده مسئول
fahmadi@sru.ac.ir
۰۹۱۲- ۵۸۶۵۳۸۹

Introduction

The global emergence of COVID-19 has led several countries to set social distance regulations to avoid the spread of the disease. Obviously, the spread of the pandemic disease and its subsequent limitations led to a major disorder in the educational systems all across the world and brought about a sudden shift from traditional face-to-face classes to e-learning and virtual platforms. Unfortunately, several teachers replicated the principles of face-to-face classes in online settings regardless of the potentials and capacities of the e-learning environments while they simultaneously expected to achieve the optimal goals relying on e-learning and technology-based education.

To make better decisions for designing and developing the content for virtual classes, the teachers are required to get familiar not only with the effective methods but also their underlying rationales. As a teacher, we are mostly inclined to try out new ways to help the learners. Hence, we select the transient modes of activities despite analyzing the existing evidence on their effectiveness [1]. As a result, in addition to technical issues and the attractiveness of the electronic content, learning efficiency in online classes needs to be prioritized. It has been proved that well-designed electronic content would lead to increased learning outcomes [2]. Due to the difference between face-to-face and e-learning, making a successful shift from the former to the latter one seems to be complicated particularly for such subjects as physics, which by itself requires repetition and adaptation to the environment and entails higher-order thinking skills [3]. Researchers hold that developing and implementing educational content to form an accurate perception of the concepts makes a tremendous impact on how the learners acquire them since having a good understanding of the learners' learning procedures contributes to the more desired planning and implementation of the materials [4].

Bloom's taxonomy of the learning levels is one of the globally known theoretical frameworks for describing learning [5] and presents three domains namely cognitive, affective, and psychomotor for categorizing the learning objectives. However, learning is not the only ultimate goal of educational programs. Rather, lifelong learning is the desired outcome. The cognitive domain of this taxonomy entails such objectives as recalling, retrieving knowledge and developing mental skills and capabilities. Six categories were considered for the cognitive domain including knowledge, comprehension, application, analysis, synthesis, and evaluation. To lead the students towards achieving these levels, material developers must design the content based on the human brain capacity.

Hence, to enhance the learning levels in an e-learning context, material developers must develop structurally organized content [6]. The educational programmers must ensure that the content gears to the learners' cognitive processing and enhanced learning. To this end, numerous factors including the learning environment, learning objectives, content difficulty, multimedia format, and their impact on cognitive loading must be considered [7]. Cognitive loading occurs when the cognitive processing is beyond the learner's cognitive capacity [8].

Cognitive loading theory is a human memory- and brain-based theory encompassing a long-term and a working memory [9-10]. Working memory refers to a system that is responsible for transient storage and manipulation of information. It acts as a mental working memory that is flexible enough to

support daily cognitive routines, requiring both processing and storing information (e.g. mental calculations). However, daily memory capacity is limited, and imposing extra cognitive requirements results in losing a huge bulk of information [11]. As a result, the general load of mental activities imposed on the memory at once is called cognitive loading [12].

Three kinds of cognitive load have been proposed in this theoretical framework including intrinsic cognitive load, extraneous cognitive load, and germane cognitive load [12]. The load that must be learned due to the nature and interaction among the content elements is called intrinsic cognitive load; the load that is created through the mode of presenting information and prevents the accurate schemata from being created is called extraneous cognitive load. Contrarily, germane cognitive load is formed when the imposed load by the educational features improves the schemata formation and makes a positive impact on learning [13]. Hence, educational programmers must increase the germane cognitive load to a large extent, decrease the extraneous cognitive load, and control the intrinsic cognitive load [10].

Learning environments can influence the cognitive load and thereby, make an impact on learners' understanding, thinking, and learning [14]. Accordingly, changing the learning environment from a face-to-face class to an electronic setting requires fundamental changes in planning and developing content so that the learners can experience deep and meaningful learning. Deep learning depends on the type of learners' cognitive processes while learning a topic. These processes involve: I. Selection: paying attention to important aspects of input, II. Organization: organizing the input in a coherent way, III. Integration: relating the input to the existing knowledge in long-term memory [15]. Multimedia educational programmers must avoid extraneous cognitive load since spending more energy for processing information leads the learners to have lower cognitive capacity for being involved in the learning experience [16]. Multimedia content means a combination of several modes of presentation including text (oral or written), static graphic designs (pictures, diagrams, etc.), and dynamic graphic designs (animations, movies, etc.) [17]. Multimedia presentation of information is effective in learning science, namely natural sciences [18] and physics [19]. Students learn physics via various tools such as words, pictures, diagrams, tables, movies, etc. which can be applied to describing physical phenomena. It seems that several presentation modes are employed in transferring information and supporting knowledge in teaching physics. The results of various studies have demonstrated that multidimensional presentation of information promoted the learners' conceptual understanding of physical issues and improved their problem-solving skills [20,21]. Although using various presentation modes enjoys the potential to support the learning procedures, it may result in extraneous cognitive load among the learners and have a negative impact on their learning procedures unless their cognitive structure and limited capacity of the working memory are taken into account [22].

According to Mayer, [23,24] educational content must be based on individuals' brain capacity and how they process information. The cognitive load theory provides a set of principles resulting from numerous studies on optimal educational materials development [8,10,24,27]. These principles include:

A**.** Coherence principle (omitting the extra and unnecessary materials leads to better learning).

B. Segmenting principle (segmenting complicated content is simplified into more controllable parts.

C. Signaling principle (cognitive load is lowered by presenting clues to the learners regarding the selection and organization of the content).
D. Multimedia principle (applying a combination of words and pictures is more effective than merely using words).
E. Modality principle (a combination of audio-visual resources is more efficient than presenting the content through one of these senses).
F. Spatial contiguity principle (relevant words and pictures are better to be proximate).
G. Temporal contiguity principle (simultaneous presentation of audio-visual resources makes it unnecessary to keep one slide in the working memory till the next slide is shown).
H. Redundancy principle (redundancy occurs when the same content is presented in the oral and written format and hinders the information processing).
I. Individualization principle (considering individual differences in assigning tasks and regulating their level of difficulty leads to better results).
J. Feedback principle (providing the learners with feedback results in the required cognitive processing for deeper learning).
K. Expertise reversal principle (the learners' differences in terms of their levels of knowledge must be considered (i.e. presenting information must be different for the beginners and experts)).

Research has shown that the cognitive load of the working memory could be lowered provided that multimedia learning is facilitated by following the principles of the cognitive loading theory [28]. Bearing this in mind, it seems that injecting the principles of cognitive load theory into the e-learning materials would significantly influence the learners' levels of learning and retention in such subjects as physics (e.g. pressure, etc.) which require various modes of presentation. Physics entails abstract concepts and the learners mostly lack the required levels of accurate understanding and recalling to notice and apply them in their daily lives. Accordingly, the current study was conducted to test the following hypotheses:
I. Developing e-learning materials based on the cognitive load theory makes a significant impact on the learners' levels of learning (i.e. knowledge, comprehension, and application).
II. Developing e-learning materials based on the cognitive load theory makes a significant impact on the learners' retention of the theme "Pressure" in physics.

Review of the Related Literature

The results of Mayer et al.'s [29] study indicated the negative effect of injecting additional and even interesting but irrelevant details in hindering learning and retention among the learners. They justified their findings relying on the cognitive load theory and multimedia learning. Furthermore, Schauer et al. [30] conducted a study and demonstrated that integrative e-learning for effective teaching of physics would lower the learners' cognitive load by supporting their individual comprehension procedures, providing multimedia access to knowledge, and catering for their individual differences.

In another study, Takir and Aksu [31] investigated the possible impact of the developed materials based on cognitive load theory on the seventh-grade students' accomplishments in Algebra. They demonstrated the facilitative and positive effect of such materials on the students' achievement and learning. Moreover, Andrade et al. [32] conducted a quasi-experimental study and explored the influence of multimedia materials and their difficulty level based on cognitive load theory and the students' learning outcomes. They randomly assigned the

students to three groups including a group receiving text and graphics, a group receiving voice and text and graphics, and a group receiving video, voice, text, and graphics. The results of their analysis revealed that the first group, with lower intrinsic cognitive load, gained higher scores in the post-test. Similarly, the students with the higher germane cognitive load had higher scores in the post-test. Also, in the second and third groups, the students with lower extraneous cognitive load obtained higher scores in the post-test. The results of a study by Camos and Portrat [33] demonstrated that repetition and cognitive review were needed to increase the information learning rate in the participants' working memories. They also found out that applying cognitive-load-based principles would enhance the learners' retention.

Additionally, in a study by Grech [34] in Malt, multimedia principles of learning were used to develop the PowerPoint slides. The findings showed that taking into account the principles of cognitive load theory and multimedia learning in developing the slides led to a lowered imposed cognitive load on the working memory and expedited the learning. Moreover, Becker et al. [35] studied the use of Tablet-based visual analysis in enhancing learning of such concepts as static and accelerating movement to confirm the significant role of lowering cognitive load on learning efficiency. Their analysis demonstrated that extraneous cognitive load during the experiment-based learning procedure was significantly lower in technology-based teaching (if the principles of cognitive load theory and multimedia learning are followed) compared to that in traditional education. Moreover, Tindall-ford et al. [36] showed that presenting the basic courses of electrical engineering would be more preferred provided that audio-visual resources were employed. They took into account the memory cognitive load and estimation of the educational effectiveness to analyze the data.

A review of the existing literature on the cognitive load theory indicates that the principles have been employed for designing educational multimedia and software to complement face-to-face instructions. The emergence of COVID-19 and the sudden shift to virtual education and the application of e-learning content in online courses seem to have created a niche, exploring the influence of employing the principles of cognitive load theory in designing the e-learning content on the students' levels of learning and retention. Most studies have focused on the challenges, demerits, and merits of online courses; teachers, particularly basic sciences and physics teachers, have been searching for appropriate techniques and software to present the content on virtual platforms. Hence, the current study attempted to fill this void by highlighting the possible impact of implementing the principles of the cognitive load theory in developing the e-learning content on the students' levels of learning and retention in physics classes.

Method

The current applied study adopted a quasi-experimental design via administering pre-test and post-test in an experimental and a control group.

Participants

The statistical population consisted of all the female ninth graders in Tehran, District 17 in the academic year 2021-2022. Multistage stratified random sampling procedures were used and a total number of 120 learners were included in the sample. They were divided into two groups of 60 and were assigned to the experimental and control groups.

Instruments

To gather the required data, a researcher-made test was used. It included 20 multiple-choice items which were developed relying on the objective-content table, subject, and Bloom's taxonomy based on the Physics textbook. The items were given to experienced teachers of science and physics to be checked in terms of content validity. To check for the test reliability, Cronbach's alpha coefficient was calculated as 0.80, indicating an acceptable degree of reliability. It is worth noting that the same test was used for the delayed post-test.

Procedure

The students took part in a three-week virtual empirical sciences course comprising six sixty-minute sessions. Before offering the course, the educational objectives of chapter 8 of the empirical sciences textbook in the ninth grade related to the subject "pressure" were determined using the teacher's manual and eliciting the experienced sciences and physics teachers' expert comments. Then, their level of cognitive processing was identified based on Bloom's taxonomy. The objectives were categorized into three groups of knowledge, understanding, and application. Accordingly, the test items were developed as follows: 6 items at the level of knowledge, 12 items at the level of understanding, and 2 items at the level of application. Following that, the virtual classes lesson plans were developed and confirmed by the experienced teachers. It is worth noting that the lesson plans for the experimental group were designed based on the theoretical and empirical principles of cognitive load theory. Afterward, the content was prepared. The pre-test was administered to both experimental and control groups. In this regard, the control group received the same instruction in the virtual classes and the experimental group received the cognitive-load-based instruction. Finally, the post-test was administered and the learners' scores were recorded. The same researcher-made test was used in both pre-test and post-test stages. To assess the students' long-term retention, the delayed post-test was administered after a two-week interval and the scores were recorded. Finally, it should be mentioned that we used available data through the local source which was provided by our own research team, so all the data can be provided.

Design

The materials were designed based on the cognitive load theory for the experimental group. Having reviewed the existing literature, the content was developed based on the cognitive load theory and multimedia design. The following issues were taken into account:

A. Before designing the educational content, the pre-test scores of the experimental group students were analyzed to ensure the basic level of knowledge about pressure among them (Expertise reversal principle).

B. For designing the content, several audio-visual media were employed. Several media including text, pictures, sound, and films were used in order not to confine the scope of the educational content to merely two or more particular media (Multimedia principle).

C. All the videos and voices were prepared by the content developer and other colleagues' files were not used. Moreover, to simulate the face-to-face classes and board, a light pen was used to write, i.e. writing by means of software was avoided (Individualization principle).

D. The educational program was implemented in the form of flipped classes. In this way, the educational content of each session was uploaded on Shad for the experimental group and the students were given time to watch the files and learn. The beginning of each session was allocated to examining the homework and asking questions (Self-speed observing principle).

E. Taking into account the audio-visual channels, the content was developed in a way that the visual content lacked the text so that the capacity of the channel was not fully saturated (Modality principle).

F. The clarity was considered in choosing the pictures to convey the message more conveniently. The low number and high quality were taken into account to avoid using pictures of cognitive overload. To this end, the music was not included in the educational content; eliminating the extra sounds could draw the students' attention. Moreover, no extra pictures were used to decorate the class environment (Coherence principle).

G. A mouse was used to show the content on the videos. Moreover, to draw the students' attention to the major points, pens of different colors, boxes, and margins were used (Signaling principle).

H. The chapter was divided into several sections and short video files were prepared for each section to avoid long and nonstop videos. Each topic was completely tackled in each video file (Segmenting principle).

I. In multimedia files, the slide with a picture of the concept of pressure was followed by the slides including the relevant text and explanations. Moreover, the presentation of the information was accompanied by the relevant concepts in each video file. The text, pictures, and sounds were relevant and coherent (Spatial contiguity principle).

J. As regards the experiments, the explanations were presented while the experiment was being conducted. The coordination of the audio and video files was considered (Temporal contiguity principle).

K. The teacher's explanations of the experiments in the video files were not accompanied by the transcription of the experimental procedures (Redundancy principle).

Since the students were familiarized with the concept of "pressure" for the first time, it was tried to divide the content into separate video files to control the possibly imposed cognitive load. A step-by-step approach was adopted to present the new content in which the prerequisites were provided and the underlying concepts (e.g. force, floor, etc.) were reviewed.

As different media could be used to present the concept of "pressure", inappropriate use of the educational tools may lead to an increased cognitive load; hence, the link between concepts and the relevance of the sub-themes was considered to present a clear picture of the target content. To this end, attractive content and decorative features that might deviate the students were excluded from the files.

Fig. 1 displays one of the slides for the experimental group in which cognitive load theory principles were taken into consideration.

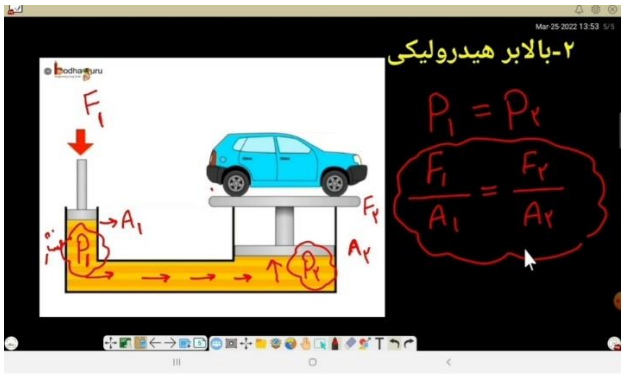

Fig. 1: Part of the multimedia content for the experimental group (observing such principles as Multimedia, Coherence, Modality, Spatial contiguity, Temporal contiguity, and Signaling).

Appropriate cognitive load is essential to learning and can be represented by the learners' memory attempts to create and automatize their mental schemata. Repeated use of the knowledge and skills would lead to autonomous performance, which in turn, overcome the limitations of the working memory. To increase the appropriate cognitive

load, such procedures can be taken as presenting more examples, posing more questions, providing problem-solving tasks, stretching the learners' imagination, giving a summary of the content, illustrating the relationship between and among the content, and gradual omission of the guidelines. Fig. 2 shows the content for the experimental group which entailed educational designing procedures to increase the appropriate cognitive load.

Fig. 2: Part of the multimedia content for the experimtal group (observing such principles as Multimedia, Modality, Redundancy and Individualization).

Results and Findings

To analyze the data, SPSS (Version 20) was used. To answer the research question related to learning based on their levels of cognitive processing (knowledge, understanding, and application), co-variance analysis was used. To check the data obtained from the delayed post-test, an independent samples t-test was run. To test the first hypothesis, the scores related to the level of learning of the test items were separately analyzed at three levels of knowledge, understanding, and application. The results of covariance analysis for the knowledge level are presented in Table 1.

According to Table 1, omitting the impact of the pre-test and considering the F coefficient, the results revealed a significant difference among the moderated mean values for the knowledge level between experimental and control groups ($P \leq 0.05$). Hence, developing the e-content based on the principles of cognitive load theory significantly influenced the learners' level of knowledge in the "pressure" subject. Table 2 displays the results of the analysis of the data related to the understanding level.

As Table 2 shows, omitting the impact of the pre-test and considering the F coefficient, the results revealed a significant difference among the moderated mean values for the understanding level between experimental and control groups ($P \leq 0.05$). Hence, developing the e-content based on the principles of cognitive load theory significantly impacted the learners' level of understanding in the "pressure" subject. Table 3 illustrates the results of analysis of the data related to the application level.

As Table 3 indicates, omitting the impact of the pre-test and considering the F coefficient, the results revealed a significant difference among the moderated mean values for the understanding level between experimental and control groups ($P \leq 0.05$). Hence, developing the e-content based on the principles of cognitive load theory significantly influenced the learners' level of applying in the "pressure" subject.

According to the results, it might be concluded that developing the e-learning content based on the principles of the cognitive load theory would make a tremendous impact on the students' levels of learning while they were taught the "pressure" subject. Table 4 demonstrates the results of descriptive statistics for the second hypothesis.

Table 1: Results of covariance analysis for the test items at the knowledge level

Source	SS	df	Ms	F	Sig	Effect size
Pre-test	1727.676	1	1727.676	1125.146	0.000	0.906
Group	75.595	1	75.595	49.231	0.000	0.296
Error	6.945	1	6.945	4.523	0.036	0.037
Total	179.655	117	1.536			

Table 2: Results of covariance analysis for the test items at the understanding level

Source	SS	df	Ms	F	Sig	Effect size
Pre-test	50.423	1	50.423	29.475	0.000	0.304
Group	4.314	1	4.314	2.522	0.0115	0.31
Error	196.730	115	1.711			
Total	13517.000	118				

Table 3: Results of covariance analysis for the test items at the application level

Source	SS	Df	Ms	F	Sig	Effect size
Pre-test	0.070	1	0.070	0.431	0.013	0.104
Group	0.468	1	0.468	2.866	0.043	0.124
Error	19.113	117	0.163			
Total	21.000	120				

Table 4: Descriptive statistics for delayed post-test

Groups	Number	Mean
Control	14.933	14.933
Experimental	16.983	16.983

Table 5: Levene's test of homogeneity of variances

Variance	df1	df2	F	Sig
Retention	1	118	0.42	0.51

Before running an independent samples t-test, the variances of both groups were checked via Levene's test (See Table 5), indicating no significant difference between the experimental and control groups.

Having ensured the homogeneity of the two groups, an independent samples t-test was run. Table 6 displays the results.

As Table 6 shows, there was a significant difference between the experimental and control groups (t= -4.88, $p \leq 0.05$). Accordingly, considering the principles of cognitive load theory and the limitations of the working memory in developing the e-learning content related to pressure increased the learners' retention in the experimental group.

Table 6: Results of the t-test for the second hypothesis

Variable	Group	Mean difference	Standard deviation difference	Levene's test	T	P
0.000	Control / Experimental	-2.05	0/42	4.01	-4.88	0.000

Discussion

The current study aimed to investigate the impact of observing the cognitive loading theory in designing electronic content of a concept in physics (pressure) on the students' levels of learning (knowledge, understanding, applying) and their retention of this concept. The findings revealed that the students who received cognitive loading theory-based multimedia content outperformed those in the control group. The results showed that accessing various levels of learning in multimedia content would make learning meaningful, and thereby, the students would be enabled to establish a meaningful link between the presented content and processing the information in their working memory. As a result, they would be able to identify the key concepts, organize the information in their memory, and merge this information into the previously existing bulk of knowledge. Paying attention to the cognitive constructs, underlying the cognitive loading theory, contributes to designing such meaningful and effective content for educational settings. Hence, in online education, the limitations of the working memory and principles for overcoming these obstacles must be considered so that the extra cognitive loading is omitted, and thereby, learning becomes easier so that the content helps the learners enhance their levels of learning.

The findings of the study also demonstrated a significant difference between the experimental and control groups in terms of the retention of the presented content after a two-week interval. This might indicate that multimedia content allows the learners to practice at their own appropriate time repeatedly, which results in a higher degree of retention. Designing the content based on the principles of the cognitive load theory, working memory storage, and retrieving information in long-term memory would make learning more meaningful and effective (van Merriënboer & Sweler, 2005; van Merriënboer & Kester, 2005). In this regard, the results were in line with those of previously conducted studies (Mayer et al., 2001; Schauer et al., 2007; Takir & Aksu, 2012; Andrade et al., 2015; Grech, 2018; Becker et al., 2020).

Conclusions

Attending to the students' cognitive constructs and taking into account the characteristics and limitations of the working memory and observing the cognitive load theory principles in designing the electronic content (e.g. physics which requires several media to represent the concepts) would enhance the levels of the students' learning (i.e. knowledge, understanding, applying) and increase the retention of the content.

Hence, it is recommended to pay attention to the use of media in teaching physics since it would lead to a higher degree of learning and facilitate meaningful learning, thereby, enabling the learners to establish a link between the information presented visually and information processed verbally in the working memory. This leads to effective pruning of information so that the audio-visual channels are not occupied by unnecessary and irrelevant extra information [8]. Indeed, if e-learning was confined to transferring information to the students in an undesirable procedure, numerous great lecturers could be asked to record the relevant speeches and provide the students with them [37]. Accordingly, multimedia planners must learn not only the technical considerations and layout designing of the e-learning content but also the strategies for effective presentation of information to avoid imposing extra cognitive

load and facilitate the smooth flow of knowledge constructs in the learners' long-term memory.

Despite its implications and applications, the study had some limitations. The sample size was small and only female learners were included in the study. Some other limitations included the focus on one subject in one grade and the low speed of the internet for uploading and downloading the content in e-learning settings.

According to the findings of the current study, teachers in general and basic sciences teachers, in particular, are recommended to become familiar with the cognitive constructs and cognitive load theory to develop the educational content (in face-to-face or online classes) that enhance the students' level of learning and, by no means, confine the material development to the technical and physical layout considerations. Accordingly, similar studies to the present one can be carried out for other concepts in physics, other subjects, and other grades.

Authors' Contribution

The article was extracted from the MA thesis of the first author, who was responsible for conducting research, collecting the required data, and analyzing the data. The second author was the supervisor and the responsibility for the content is hers. In addition, the second author was responsible for the topic, design of the study, and extracting the results. The third author helped in organizing and writing the manuscript and enhanced and revised the early draft of the paper.

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Conflict of Interest

There is no conflict of interest.

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AUTHOR(S) BIOSKETCHES

Zahra Rahbar is a Master's student in the Department of Physics at Shahid Rajaee Teacher Training University, Tehran, Iran. She study physics education and her research interest is in field of cognitive psychology theories in science education.

Rahbar, Z. Master's student in physics education, Shahid Rajaee Teacher Training University, Tehran, Iran

rahbar72zahra@gmail.com

Fatemeh Ahmadi is an Associate Professor in the Department of Physics at Shahid Rajaee Teacher Training University, Tehran, Iran. She get her Ph.D of physics with a specialization in cosmology from Shahid Beheshti University. Her research interests are in the fields of physics education, theoretical physics and cosmology.

Ahmadi, F. Associate Professor, Physics, Shahid Rajaee Teacher Training University, Tehran, Iran

fahmadi@sru.ac.ir

Mavadat Saidi is an Assistant Professor of TEFL in the Department of English Language at Shahid Rajaee Teacher Training University, Tehran, Iran. Her research interests include discourse analysis, English for academic purposes, and teacher education.

Saidi, M. Assistant Professor, TEFL, Shahid Rajaee Teacher Training University, Tehran, Iran

m.saidi@sru.ac.ir

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ORIGINAL RESEARCH PAPER

Exploring the Effect of Google Docs on Learning Technical Vocabulary in ESP courses

Z. Cheraghi*, H. Omranpour, A. Motaharinejad, F. Moghisseh

English Department, Faculty of Humanities, Shahid Rajaee Teacher Training University, Tehran, Iran

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* Corresponding author
z.cheraghi@sru.ac
(+98912) 5383046

ABSTRACT

Background and Objectives: Regarding the fact that most of the submitted official documents are written in or translated into English, all English for Specific Purposes (ESP) learners are not only required to learn professional knowledge but also need to know English technical vocabulary in their field of study. Therefore, enhancing technical vocabulary competence (VC) is one of the aims defined by ESP learners. In this new digital era, various techniques facilitate vocabulary learning via using Information and Communication Technology. Due to the advent of technology and the developmental trend of learning, learners are provided with the opportunity to use online and mobile applications in a very wide range to develop their English vocabulary knowledge. Accordingly, this study was an attempt to explore the effect of using Google Docs on ESP students' vocabulary learning. The research also intended to find out the learners' perceptions toward using Google Docs on learning and practicing target technical vocabulary.

Materials and Methods: To this end, a quasi-experimental research design was employed for gathering both quantitative and qualitative data. In this regard, 40 Iranian ESP nursing learners who were randomly allocated into an experimental (n=20) and a control group (n=20) participated in this study. The learners in the control group were asked to use their personal traditional techniques for learning technical vocabulary, while the experimental group was assigned to use Google Docs for vocabulary learning. Four data-gathering instruments were utilized; first, an Oxford Placement Test (OPT) was employed for homogenizing the participants. Second, each group underwent a pretest and a posttest to assess their learning of the assigned vocabulary lessons. Then, a survey was conducted among the experimental group to investigate learners' motivation about learning technical vocabulary through using Google Docs. Lastly, a semi-structured interview was employed with the experimental group to explore their thoughts and perceptions toward using Google Docs. A series of t-tests, including two paired sample t-tests and one independent samples t-test were employed to compare the performance of the two groups in terms of learning technical vocabulary.

Findings: Subsequent to validating the assumption of normality, the results of an independent samples t-test revealed that there was a significant difference between the students of the experimental and control groups on post-test scores. The obtained data revealed that both experimental and control groups were able to improve their vocabulary learning successfully. However, comparing the two groups showed that the experimental group performed significantly better than their counterparts in the control group who used their practical traditional techniques for learning specialized vocabulary in ESP courses. Additionally, face-to-face semi-structured interview results uncovered that the experimental group learners had positive perceptions toward using Google Docs for learning technical vocabulary.

Conclusions: Counting on the integration of technology into the curriculum of learning/ teaching ESP, it was concluded that Google Docs was an effective website tool that boosts, engages, and motivates learners to expand their technical vocabulary learning. Based on the limitation of the research, it is suggested to conduct a similar study with both male and female ESP learners, and also with a larger sample. The results of this research contain considerable implications for ESP instructors and learners and also curriculum and syllabus designers. Incorporating ICT into ESP education has revolutionized and changed the method by which ESP material developers construct ESP materials. So, findings can be implemented in any educational contexts as well as other languages.

NUMBER OF REFERENCES	NUMBER OF FIGURES	NUMBER OF TABLES
57	1	11

مقاله پژوهشی

بررسی تاثیر گوگل داک بر یادگیری لغت در دوره‌های تخصصی زبان انگلیسی

زهرا چراغی*، هنگامه عمرانپور، عطیه مطهری نژاد، فاطمه مقیسه

گروه زبان انگلیسی، دانشکده علوم انسانی، دانشگاه تربیت دبیر شهید رجائی، تهران، ایران

چکیده

پیشینه و اهداف: با توجه به اینکه اکثر اسناد رسمی به زبان انگلیسی نوشته یا ترجمه شده هستند، تمامی زبان آموزان انگلیسی برای اهداف ویژه نه تنها ملزم به یادگیری دانش حرفه ای هستند، بلکه باید واژگان تخصصی انگلیسی در رشته تحصیلی خود را نیز بدانند. بنابراین، افزایش دانش واژگان تخصصی یکی از اهدافی است که توسط زبان آموزان انگلیسی برای برای اهداف ویژه تعریف شده است. در عصر دیجیتال جدید، تکنیک های مختلف، یادگیری واژگان را با استفاده از فناوری اطلاعات و ارتباطات تسهیل می کند. با توجه به ظهور فناوری و روند توسعه ای یادگیری، زبان آموزان این فرصت را دارند که به میزان بسیار زیادی، برای توسعه دانش واژگان انگلیسی خود از برنامه های برخط و تلفن همراه استفاده کنند. بر این اساس، این مطالعه تلاشی برای بررسی تأثیر استفاده از Google Docs بر یادگیری واژگان زبان آموزان انگلیسی با اهداف ویژه بود. این تحقیق همچنین به دنبال یافتن میزان درک زبان آموزان از Google Docs در یادگیری و تمرین واژگان تخصصی مورد نظر بود.

روش‌ها: بدین منظور از طرح پژوهشی نیمه تجربی برای جمع‌آوری داده‌های کمّی و کیفی استفاده شد. در این راستا، ۴۰ نفر از دانشجویان زبان تخصصی رشته پرستاری ایرانی که به طور تصادفی در دو گروه آزمایش (۲۰ نفر) و کنترل (۲۰ نفر) قرار گرفتند، در این مطالعه شرکت کردند. از زبان آموزان گروه کنترل خواسته شد تا از روش های سنتی برای یادگیری واژگان تخصصی استفاده کنند، در حالی که گروه آزمایش برای یادگیری واژگان از Google Docs استفاده کردند. در این پژوهش، چهار ابزار جمع آوری داده ها استفاده شد. ابتدا از آزمون تعیین سطح آکسفورد (OPT) برای همگن سازی شرکت کنندگان استفاده شد. در مرحله دوم، هر گروه برای ارزیابی میزان یادگیری دروس اختصاص داده شده تحت یک پیش آزمون و یک پس آزمون قرار گرفتند. سپس، نظرسنجی در بین گروه آزمایش برای بررسی انگیزه زبان آموزان در یادگیری واژگان تخصصی با استفاده از Google Docs انجام شد. در نهایت، یک مصاحبه نیمه ساختاریافته با گروه آزمایش برای بررسی افکار و میزان درک آن ها در مورد استفاده از Google Docs به کار گرفته شد. مجموعه‌ای از آزمون‌های t شامل دو آزمون جفتی و یک آزمون تی مستقل برای مقایسه عملکرد دو گروه از نظر یادگیری واژگان تخصصی و برای تجزیه و تحلیل داده‌های به‌دست‌آمده از پرسش نامه و مصاحبه نیمه‌ساختاریافته، از آزمون تی تک نمونه‌ای و تحلیل محتوا استفاده شد.

یافته‌ها: پس از اعتبار سنجی فرضیه ی نرمال بودن داده ها، نتایج آزمون تی مستقل test- نشان داد که بین دانشجویان گروه آزمایش و کنترل در نمرات پس آزمون تفاوت معناداری وجود دارد (t= - 0. 573 ،Sig = 0.000، با ۹۵ درصد فاصله اطمینان از ۸.۳۰- تا ۵.۷۵-). داده های به دست آمده نشان داد که هر دو گروه آزمایش و گواه توانستند یادگیری واژگان خود را با موفقیت بهبود بخشند. با این حال، مقایسه دو گروه نشان داد که گروه آزمایش به طور معنا داری از همتایان خود در گروه گواه عملکرد بهتری داشتند. علاوه بر این، نتایج مصاحبه نیمه ساختاریافته نشان داد که فراگیران گروه آزمایشی میزان درک مثبتی نسبت به استفاده از Google Docs برای یادگیری واژگان تخصصی داشتند.

نتیجه‌گیری: با توجه به ادغام فناوری در فرآیند یادگیری/ یاددهی زبان انگلیسی برای اهداف ویژه، این چنین نتیجه گرفته شد که Goggle Docs یک ابزار موثر است که باعث تقویت، مشارکت و انگیزه زبان آموزان برای گسترش یادگیری واژگان تخصصی خود می شود. با توجه به محدودیت‌های پژوهش، پیشنهاد می‌شود مطالعه مشابهی با فراگیران انگلیسی با اهداف ویژه مرد و زن و همچنین با نمونه بزرگ‌تر انجام شود. نتایج این تحقیق حاوی مفاهیم قابل توجهی برای مدرسان و فراگیران انگلیسی با اهداف ویژه و همچنین طراحان برنامه درسی است.

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یادگیری واژگان تخصصی

*نویسنده مسئول
z.cheraghi@sru.ac
۰۹۱۲-۵۳۸۳۰۴۶

Introduction

Information and Communication Technology (ICT) has modified almost everything in our lives which yields to producing incredible resources for the process of teaching and learning. Being connected and interested in technological devices, learners of the technology-enhanced

generation are called ‘digital natives’ [1]. The learners of the latest generation have great comfort and a high tendency toward using technology, for instance, surfing the internet, using digital applications, and sending short messages [2]. Considering the fact that today’s learners learn differently than those a decade ago, instructors must apply innovative techniques for better learning, particularly for learning technical vocabulary effectively by ESP learners.

ICT has been developing for a while now with lots of new developments. Stakeholders in education have focused on integrating ICT into the classroom during the information era. Because of the increased availability and prominence of ICT, countries are taking steps to improve education by forming policies, investing in technological infrastructure, and training teachers.

One of the pivotal aspects of learning any second or foreign language is learning vocabulary. Mastering a high number of English words is essential for EFL/ESL learners, particularly for learners of ESP. Because VC plays an important role in efficient spoken and written instruction, interacting in the target language effectively necessitates a wide range of vocabulary size [3]. Furthermore, vocabulary learning is considered to be a central component of the development of language skills [4]. Consequently, there is a strong need to use novel vocabulary learning strategies, especially for ESP students.

Scholars believe that ESP is an approach to teaching and learning English as a foreign language [5]. Nevertheless, in comparison with other pedagogical approaches, the content and purposes of ESP are related to the particular needs of target learners [6]. Concerning the transformative nature of language from one context to another, (i.e., medical, engineering, politics, tourism, etc.), employing an innovative technique for learning ESP vocabulary is of utmost importance. Accordingly, people need not only to have acceptable general English knowledge, but also a high amount of vocabulary proficiency and communicative use of the language concerning their particular field of study or profession [7].

Most language learners consider vocabulary to be one of the most challenging components of language learning. Some studies concluded that learning and practicing vocabulary through technology has various advantages [8]. Moreover, the importance of learning technical vocabulary has been discussed in some research studies [9]. Although students are enthusiastic at the beginning of the semester, it has been noticed that as time goes on, their drive wanes [10]. Their performance also tends to deteriorate. Due to the correlation between motivation and language learning, this decline has occurred [11]. It has been demonstrated that constructing the instructional design in conformity with John Keller's model of motivational design can help avoid the negative effects of low motivation in EFL classrooms [12].

A number of investigations indicate that digital flashcards, such as cram.com, Quizlet, along with Studyblue, serve an important role in language learning because they provide additional advantages [13]. According to Bilová the performance of learners demonstrated that Google Docs and Quizlet are effective tools for not just vocabulary learning but also for language teaching. The suggested approach was developed for official English classes, but it can be applied to any language course [14].

Regarding the conducted studies, investigating the effect of Google Docs as an ICT tool for learning specialized vocabulary to reduce challenges in ESP classes has not been

explored so far. Google Docs, provided by Google Workspace for Educational institutions has been identified as one of the supportive and advantageous technological resources for acquiring skills and sub-skills, whether in an academic setting or a career for professionals [15]. According to Nasri et al., the platform has also contributed to students' educational experiences, especially by facilitating its promotion of teacher feedback in Google Docs [16]. This tool also supports students' educational involvement and helps them to broaden their educational techniques [17]. Google Docs has also been shown to help poor performers in terms of collaboration and technological proficiency [18]. To that end, Google Docs may find favor with pupils as well as educators. Expressly, there is a gap in the literature with relatively no study to investigate the effect of using Google Docs on technical vocabulary learning of Nursing students. Hence, the current study deals with English vocabulary learning of intermediate nursing students at Golestan University in Golestan, Iran. The article starts by providing an introduction of the findings related to vocabulary-building strategies, then explores the theoretical background of ICT and concludes with a discussion of the role of ICT in vocabulary learning. The following section introduces Google Docs and related research, and the final section states the participants' perceptions toward using Google Docs.

Considering the importance of learning technical vocabulary and also the efficiency of integrating technology into the process of learning and teaching, this study intended to answer the following research questions:

- Does Google Docs affect ESP learners' vocabulary learning?
- Does learning vocabulary through Google Docs make a significant impact on nursing students' motivation?
- How do students perceive the use of Google Docs online website on their ESP vocabulary development?

Review of the Related Literature

Theoretical Background

The current study's investigation into the impact of Google Docs applications on vocabulary learning is based on two theoretical pillars: Technology-enhanced language learning, and the theory of Cloud computing. For many years, technology-enhanced language learning has been a major research topic in language instruction [19-20], and it has received several positive feedback. Golonka et al. carried out a significant study that summed up a wide range of technologies used in language learning from 1996 to 2010 [21]. It is worth mentioning that 1996 was almost the beginning of the emergence of educational technology for language education. Technology, according to Golonka et al. (1) enhanced language learners' incentive to learn, effectiveness, and interaction frequency, (2) established learners' language skills and knowledge (e.g., speaking, listening, vocabulary, grammar), in addition to metacognitive and metalinguistic expertise, (3) enhanced sources of input, and (4) inspired input from peers. The study supported the efficacy and feasibility of technology-enhanced language learning [21].

Furthermore, Cloud computing, as defined by the National Institute of Standards and Technology (NIST), is a model for providing convenient, on-demand network access to a shared pool of configurable computing assets (e.g., networks, storage devices, servers, applications, and services) that can quickly be supplied as well as published with minimal management effort or service provider

collaboration [22]. The cloud model promotes accessibility. It should be pointed out, nevertheless, that cloud computing remains a developing paradigm. Cloud computing is distinguished by its capacity to be accessed from any location with an active Internet connection. The ability to advocate on-demand self-service enables users to have computing capabilities without requiring a relationship with the provider of a service. It enables the user to obtain data in real time rather than having to wait for the service to "boot up" [22]. Another significant benefit is the ability to access data on any network, regardless of client platform (mobile phone, laptop, etc.). Having access to data from any place means that helpful resources are not being wasted. This brings us to a further aspect of location-independent resource pooling. Cloud computing may redirect inactive assets and shift them to where consumer demand is highest by freeing up precious resources [23]. Given that the goal of this paper is to investigate the impact of Google Docs on college students, the characteristics of these models would be applicable to our investigation.

Learning Specialized vocabulary in ESP context

The fundamental content of any ESP course is specialized vocabulary [24]. Professional language, which includes technical, semi-technical, and general vocabulary, is included in the well-known categorization of receptive and productive vocabulary [18]. Specialized vocabulary is elucidated as "content words whose meaning is restricted to the specific subject, characterizes the specific language as an individual area of the global language, and constitutes the terminology of the domain" [24, p. 162]. Semi-technical vocabulary is defined as general words of content that become specialized in a particular field while remaining accessible in general settings [25]. Finally, the term ‘general vocabulary’ "refers to those phrases that are familiar to the general speaker and exist with technical and sub-technical vocabulary in a specialized content" [26, p. 105]. Specialized vocabulary is likewise strongly related to terms. The phrases, recognized as lexical units transferring knowledge, establish and represent the degree of specialization of words. As a result, Terminological vocabularies are the key component in teaching medical settings [27], and these include morphological variants, orthographic variants, elliptical forms, and abbreviations.

Learning Vocabulary on Google Docs

Google Docs (official Google Docs) is a kind of cloud software powered by Google Drive. [28] As the name recommends, it is an instrument for sharing and co-altering documents. It is for nothing for all Gmail holders and at the same time, an unlimited number of people can utilize it. When Google Docs is implemented for teaching purposes, it suggests new occasions, besides facilitating work. For instance, to create various types of student-generated content literature recognizes many regions in which this apparatus ended up being valuable, with collaborative learning and community-oriented composing being the most well-known [14]. Various composers concentrated on the effects of utilizing Google Docs for collaborative learning by contrasting the consequences of similar studies in two groups of students: one group uses Google Docs and the other uses a traditional face-to-face system.

Advantages and Challenges of Utilizing ICT in ESP

As stated by Tan, the current world of globalization and competitiveness has placed a greater value on preparing students (future

specialists) to be creative, think logically, and solve worldwide issues efficiently [29]. Some of the features of an ESP techno-enriched environment for learning, as described by Butler-Pascoe and Keshtiarast et al., involve creating communicative activities representative of the specified occupation; providing understandable field-specific input to students; making easier student creation; utilizing genuine resources from particular fields and professions; supplying cognitive capacities and critical thinking abilities; and incorporating cooperative learning [30].

Rafi et al. proposed that higher learning educational materials be enhanced by using electronic libraries and Internet-based knowledge. They additionally stated that university professors' experiences, students' interests, and requirements must be incorporated into curriculum design decisions via a web-based need evaluation [31].

Previous research on ICT integration suggests that how instructors understand the importance of ICT in teaching and their perception of capacity in using ICT influence their views toward ICT use, as reported by Goodwin et al. It was also discovered that students' and teachers' risk-taking opinions were an indicator of the relationship between a pair of problems, which includes cognitive playfulness as well as assumed ICT importance [32]. For instance, Mahdum et al. found that teachers' prior experience with ICT, convictions about the benefits of ICT, and the perceived importance of ICT in teaching all influenced their use of ICT in the classroom [33].

Plenty of educators have not used technology in their classrooms due to a lack of time, understanding, and enthusiasm [34]. According to some investigations, the main barriers to establishing CALL in the Iranian EAP context are a lack of supplies, inadequate training programs for educators, and teachers' lack of technological understanding. Furthermore, other studies revealed that practitioners' technophobia was a barrier [30]. Therefore, it might be beneficial to suggest that "prior knowledge and achievement with this innovation are required for teachers to establish a sense of self-efficacy and a feeling of mastery before they are comfortable incorporating this technology within their instructing" [30, p. 286].

Previous Research on the Advantages of Technology to Improve Language Learning in ESP Context

Incorporating ICT tools into an efficient ESP educational setting expands the potential for understanding of a cutting-edge teaching and learning approach based on interaction, communication, and cooperation [35]. According to the findings of Akll et al., using ICT to teach ESP allows us to employ hard copy, graphics, video, audio recording, and other instructional tools. Because all activities are carried out concurrently, information is acquired more quickly and with greater passion. The ESP course, which aims to assist learners in using a language for future professional activities, is implemented through a content-based curriculum in which students acquire English by concentrating on their specialization and using genuine resources. The Internet is a great resource for authentic materials tailored to the requirements of learners, as well as a helpful instrument to establish a more flexible and stimulating educational setting [36].

The result of a study which has been done by Horvat et al. indicates students prefer using Moodle learning management system in ESP class because of its collaborative learning environment and they believe online tools can pave the road for improving their skills. They

concluded that this application was not bored easily and they were eager and more motivated and interested in learning independently [37].

Menéndez-Otero et al. investigated the use of ICT in an ESP course. Their findings demonstrated that Office and Moodle are effective deterrents to faculty unprofessional behavior and student opportunities. compared to face-to-face cooperation, all technological activity can be quickly, completely, and consistently recorded, tracked, and used as verification if necessary. As a consequence, instructors will be hesitant to abdicate their course management responsibilities, and only learners who have compelling reasons for believing they have been unjustly evaluated may challenge their scores. In every case, while ICT is incorporated into the evaluation procedure, just a few pupils will believe they have been unjustly or unequally examined. However, the advantages of ICT do not stop there [38].

Tan supported that the use of ICT has changed the roles of a teacher and a student in the ESP educational process: the former is transformed from a translator of knowledge into a moderator of students' intellectual activity, and the latter becomes an active participant able to transform information and perform intellectual activity. Teachers must complete the move from being lecturers to becoming organizers. It will become crucial for them to encourage students' critical thinking skills, promote information literacy, and introduce collaborative working practices to prepare students for their future professional activities [39].

In addition, Keshtiarast et al. discussed the benefits and difficulties of integrating ICT in ESP through the eyes of Iranian higher-learning students and teachers. The findings revealed that, in general, Iranian tertiary students and teachers had positive perceptions of using ICT in ESP courses. Nevertheless, there were some challenges, such as (a) the absence of adequate technical assistance to assist educators, (b) the ineffectiveness of training programs for educators, (c) inadequate time and passion, (d) a lack of acquaintance with employing ICT use on the part of students and teachers, (e) an absence of the necessary infrastructures and instruments difficulty, (f) a shortage of efficient online resources, and (g) the challenge of summative evaluation in ESP courses with a large number of (h) fear of technology, (i) Abuse such as chatting and networking on social media, which cause attention to be diverted. In the Iranian context, these variables impede the integration of ICT in ESP instruction at higher education institutions. This study also looked into the benefits of ICT integration in ESP, the benefits of ICT techno-enriched ESP courses using ICT-based materials including improving communication on professional problems between students and teachers in class and outside of class, making easier collaboration between students, creating self-determination, increasing self-motivation, allowing teachers more planning time, providing genuine resources from their significant, and boosting high school graduation rates [30].

Method

The present research aimed at investigating the effect of an independent variable, i.e., Google Docs on technical vocabulary learning of nursing students, the dependent variable.

Participants

Based on the Convenience Clustered Sampling technique, a total number of 60 ESP learners took an Oxford Placement Test (OPT) to select a homogenized target sample. After interpreting

the scores, 40 female learners with an intermediate level of language proficiency, studying Nursing at Golestan University, Golestan, Iran, were selected as the target participants of the study. These learners, whose English language proficiency level was B1 based on the Common European Framework of Reference, were between 20-22 years. The participants were randomly divided into two groups: an experimental and a control group, each having 20 learners.

Table 1: Demographic Background of the Participants

No. of Students	40 Undergraduate Students
Gender	Female
Native Language	Persian
Major	Nursing Students
Universities	Golestan University, Golestan, Iran
Academic Years	2022-2023

Instruments

Oxford Placement Test

The Oxford Placement Test (OPT) is one of the most famous and standard tests, which is used for determining learners' level of language proficiency. The scores of 20 ESP students who filled out the consent form to participate in this study ranged between 22 and 29; as a result, those 40 students were chosen as participants. Based on Geranpayeh's guidelines [40], they met the necessary criterion by passing the intermediate level. In other words, the administrator can use this test to homogenize the participants and place them at a suitable level for a language course.

Pre- and Post-Tests of Vocabulary

Pre- and post-tests were the initial quantitative data collection instrument. The pre-treatment survey was divided into two sections. The first section was intended to collect demographic information (age, gender, smartphone and PC/tablet ownership). The second component was created to collect data on students' technical vocabulary acquisition strategies. The items in this category were developed by students' professors based on a review of prior studies as well as informal interactions with students [39]. This section included six items in which students were asked to rate their frequency of using word study techniques (items such as "I prepare a word list to remember technical words") on a 5-point Likert scale ranging from 1 (never) to 5 (always). Before the experiment, one of the instructors who is a nursing expert chose a set of technical words. This technique was used to ensure that the questions were standard and that students had no prior knowledge of them. Lastly, the teacher instructed students not to use self-reading techniques outside of the classroom and to only use the methods asked for by the instructor to acquire vocabulary throughout the project.

Pre and post-tests utilized 35 target technical vocabularies and were comparable to one another. The item forms matched the language and cognitive abilities of the learners. By piloting the test with 100 EFL young learners who were similar to the participants in the main study, the content and construct validity were established. The reliability of the pre- and post-test was also calculated, and the outcome was r= 0.86. Both the control and experimental groups received pre- and post-tests before and after the intervention.

Keller's Instructional Materials Motivation Survey (IMMS) Survey

To answer the second research question, a modified version of the 'Instructional Materials Motivation Survey' (IMMS) developed by Keller [41], was applied to the current study. More specifically, a modified version of 'Instructional

Materials Motivation Survey' (IMMS) was utilized in the current study. The questionnaire was piloted with three ESP teaching experts. According to their feedback, all of the questions were clear for participants [42].

The ARCS Model of Motivational Design is based on a thorough review of motivational literature, which resulted in the categorization of motivational principles into four structures: (A)ttention, (R)elevance, (C)onfidence, and (S)atisfaction [41]. The results of this sort of evaluation could be used to enhance the overall course design or to tailor a program to an individual's motivational needs [43]. The internal consistency reliability (internal structure evidence) of the questionnaire is reportedly outstanding: 0.82. Furthermore, we used the Keller 2010 model in the present investigation since it has been employed in various contexts and there are validated instruments assessing motivation regarding the four elements [44-45]. Participants had 30 minutes to complete the questionnaire, which included 12 questions, covering demographic information of learners.

Semi-Structured Interviews

For gathering more reliable qualitative data, semi-structured interviews were conducted to explore the participants' perceptions toward using Google Docs for learning technical vocabulary. Randomly, twelve participants from the experimental group were asked five questions about their opinions and experiences with utilizing Google Docs to study and learn technical language. For developing the questions, three colleagues who were experts in their field gave constructive feedback to alter and modify the questions. Two of these experts assisted researchers in conducting interviews and guided researchers in identifying appropriate themes during the analysis.

Data Collection Procedure

Regarding ethical concerns, the principal of Golestan University granted permission to carry out this research among nursing students. A consent form document was also used to obtain the participants' approval. The research started in early August 2022 using taking an Oxford Placement Test (OPT) to include homogenized participants in the study. Second, a vocabulary test focusing on target words selected from Career Paths English: Nursing book was developed. Afterward, the developed test was administrated as a pre-test to both experimental and control groups to ascertain their knowledge of target words before the intervention. Then, the treatment sessions started and lasted for four weeks. The target ESP words were taught and practiced by the same instructor in the two groups, however, the applied vocabulary teaching techniques were different. During the intervention, the 20 learners in the experimental group used Google Docs for learning technical words inside and outside the class, while 20 learners in the control group used traditional techniques for learning technical vocabulary. Students in this study group were exposed to texts from their course books. They were instructed to read the text, take notes, look them up in a dictionary, and finally write down and memorize the meanings of the unknown words. After the treatment period, both groups took a post-test under similar conditions on the same day.

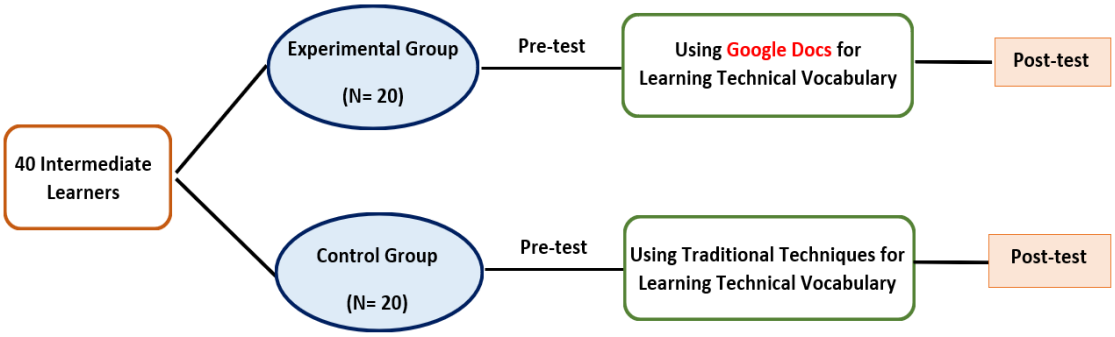

Fig. 1: Schematic Design of the Study

Then a survey was employed to explore learners' motivation toward using Google Docs for learning technical vocabulary. Ultimately, to inquire into the analysis, the learners' experiences and perceptions toward using Google Docs for learning technical vocabulary were analyzed through a semi-structured interview. This interview was carried out to put forward the participants' opinions about learning materials and the pros and cons of the learning environment, motivation, self-evaluation of success, challenges of the instruction, and suggestions for possible modifications.

Data Analysis Procedure

With respect to quantitative data analysis, the scores were registered to the Statistical Package for Social Sciences (SPSS), version 16. As the first step, two normality tests were carried out to ensure that the sample data had been selected from a normally distributed population. Subsequently, two paired sample t-tests as well as one independent sample t-test were employed to compare the performance of the two groups in terms of learning technical vocabulary. Third, data drawn from the motivation survey were analyzed via the one-samples t-test technique. The questionnaire used in this study was an adapted version of the Keller survey [41] with a reliability of 0.82. The face and content validity of the questionnaire were also examined. Finally, a program software entitled "NVivo" was used for analyzing the qualitative data extracted from the semi-structured interview.

Participants in the interview were selected depending on their willingness to take part in this section. Interviews were conducted over four weeks using Google Docs to reduce recall bias while giving participants enough time to apply what they learned. These semi-structured interviews were conducted by phone, email, or instant messaging. Anonymized interview transcripts were used for the analysis. The open-ended questions were used, and the order was established by the direction each interview participant took. Before exploring the interviewee's perception, each interview began with an overview of their most recent use of the website. The demographic characteristics of each participant (age, gender, ethnicity, educational attainment, and current or most recent occupation) were also recorded. The manuscripts ready from the interviews were reviewed several times and listened to the audio recordings to be conscious of the inner emotions and hidden meanings of their reports to gain an overall comprehension of the interviewees' perception. The participants' conversation has been simplified and displayed into an insightful transcript. Following data

collection, it was recorded, reduced to a meaningful form by Nvivo software, and computed. The transcript has been arranged into themes and subthemes for use in the qualitative results of the discussion's thematic analysis. Three distinct themes were discovered according to the subsequent headings, which were organized by the interview topic direct questions, which are provided in the results section. Furthermore, the obtained Cronbach's alpha (0.81) indicates that these questions were highly reliable. Data from the surveys and interviews were stored in encrypted documents protected by a password computer. Both instruments of this study were approved by the participants.

Design

The current mixed-method study used a quasi-experimental pre-test treatment post-test design to investigate the effect of using Google Docs on vocabulary learning of ESP learners. The target sample of intermediate students was randomly divided into control and experimental groups. The study dealt with English vocabulary learning of nursing students at a university in Golestan University, Golestan, Iran. The research was conducted from August to October 2022.

Results

This article discusses the issue of the impact of Google Docs and traditional vocabulary acquisition procedures on ESP students, examining whether there were any differences between the two methods or not. In-depth analysis and presentation of the pre-and post-test, survey, and online semi-structured interview results were done in this part. To validate the findings and provide additional insight into the participants' driving forces behind learning CALL vocabulary, the survey and semi-structured interview questions were further analyzed.

Normality test

To ensure that the data were distributed normally, the Shapiro-Wilk normality test and the Kolmogorov-Smirnov test were used. The findings of two well-known normality tests, are shown in Table 2, pre- and post-test scores for the participants in the control and experimental groups were normally distributed, according to the statistically significant value ($p > 0.05$).

Before applying an independent samples t-test on pretest scores, to make sure about the homogeneity of participants of two groups, the assumption of equality of variance should be checked based on the data in Table 3.

As detailed in Table 3, the *P* value of Leven's test is .77 which is higher than 0.05. Accordingly, the assumption of equal variance is not violated on the pretest scores of participants in the control and experimental groups.

The Differences Between Google Docs and Traditional Methods of Learning Vocabulary

Following the four weeks of study, Table 4 demonstrates significant vocabulary-knowledge gains for both groups. In both groups, there was a discernible gain in vocabulary learning, regardless of the group they were in or the activities they were likely to conduct, according to the data. However, the experimental group outperformed the control group on the posttest, as shown in the table. Particularly when compared to the control group, the experimental group's vocabulary-knowledge increases were much larger, demonstrating the success of the class's vocabulary-teaching strategy.

In accordance with the table above, the t value and mean difference in the two sets of

scores are 0. 573 and .18258 respectively, with a 95 percent confidence interval ranging from a lower bound of -8.30 to an upper bound of -5.57. Considering the *P* value, the obtained value is larger than 0.05 (*P*= 0.3> 0.05). Therefore, it can be stated that there's no significant difference in the mean scores on the pretest of vocabulary for each of the two groups. Expressly, the participants of the two groups had the same level of vocabulary knowledge before the intervention. In addition, it can be concluded that the scores of receptive vocabulary pretest of both groups don't differ, and any significant difference that may rise from the findings of the research can be regarded as the effectiveness of Google Docs.

Receding the conduction of another independent samples t-test on participants' vocabulary post-test scores, checking the equality variance assumption is a prerequisite. The results of this test are provided in Table 5.

Table 2: Test of Normality

Group		Kolmogorov-Smirnov			Shapiro-Wilk		
		Statistic	Df	Sig.	Statistic	df	Sig.
Pre-T	Control	0.165	20	0.086	0.875	20	0.344
	Experimental	0.147	20	0.238	0.948	20	0.398
Post-T	Control	0.161	20	0.141	0.938	20	0.276
	Experimental	0.178	20	0.103	0.929	20	0.164

Table 3: Leven's Test of Equality of Variance on Pretest Scores

Variable	Levene Statistics	df1	df2	Sig.
Vocabulary Learning	0.77	1	66	.779

Table 4: Independent Samples t-test Results Between Groups

Pretest Scores	T-test for Equality of Means						
	T	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
						Lower	Upper
Equal variances assumed	-0. 573	67	0.3	.18258	.969	-8.30	-5.57

Table 5: Leven's Test of Equality of Variance on Posttest Scores

Variable	Levene Statistics	df1	df2	Sig.
Receptive Vocabulary	3.019	1	66	.076

As it is demonstrated in Table 5, the obtained *P* value was .076. This value is larger than the threshold of 0.05 (Sig.= 0.76 > .05). Considering the result, variances were assumed to be equal, so the assumption of equal variance is not violated.

As Table 6. discloses *t* value is -5.579 with a mean difference of -1.1756 and a standard mean difference of .26783. The 95 percent of confidence interval spanned from a lower bound of --1.7681 to the upper bound of -1.7681. Paying attention to the *P* value, this value equals .000 which is remarkably less than 0.05. Consequently, there's a significant difference in the mean vocabulary post-test scores between the two groups. Therefore, it can be inferred that there's a visible distinction between learning vocabulary through the Google Docs approach and traditional methods.

A paired samples t-test was performed on the scores of the experimental group's pretest and post-test. This test provided the researcher with an opportunity to compare the performance of learners on the pretest vs. post-test. Analyzing the obtained data in this regard would be possible by focusing on Table 7.

As shown in Table 7, the experimental group's t value is -5.318, the degrees of freedom (df=52), the mean difference between the two sets of scores is 15.517, and the standard deviation is 7.181. Taking the P value (= 0.001) entitled Sig. (2-tailed) into account, this value is less than the 0.05 threshold, implying that there is a significant difference between the scores of the vocabulary pre- and post-tests in the experimental group. In other words, the vocabulary scores of the experimental group before and after the interval are statistically different. In the current study, the use of Google Docs in ESP classes improved learners' vocabulary learning.

Table 6: Independent Samples t-test on Posttest Scores

Posttest Scores	T-test for Equality of Means						
	T	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
						Lower	Upper
Equal Variances assumed	-5.579	66	.000	-1.1756	.26783	-1.7681	-.54612

Table 7: Results of Paired Samples t-test Within Groups

	N	M	SD	*T*	*df*	*Sig (2-tailed)*
C. G. Pretest	20	10.2400	5.5387	-1.143	52	0.001
C. G. Posttest	20	17.0458	7.0386			
E. G. Pretest	20	12.4828	9.4005	-5.318	52	0.001
E. G. Posttest	20	18.5517	4.9618			

Another paired samples t-test was applied to the scores of participants in the control group. A thorough analysis of the data presented in Table 7 gives the resources to figure out the effectiveness of Google Docs on ESP learners' vocabulary learning.

The results of performing a paired samples t-test on the pre-test and post-test scores of participants in the control group demonstrated a mean of 13.643 and, a standard deviation of 6.289. Regarding the *P* value provided in the last column (.001 < .05), there's a significant difference between the pre-test and post-test scores of participants in the control group. The results also showed a relative improvement in the test scores of the control group members due to the amount of time they spent memorizing and repeating during the four weeks.

In short, both groups improved their vocabulary knowledge during the intervention period. It can be implied that the use of Google Docs had a constructive effect on learners' technical vocabulary learning. These results answer our first question.

The Effects of Google Docs on Learners' Motivation

The authors of this study conducted an adaptation of Keller's 'Instructional Materials Motivation Survey' (IMMS). This survey was utilized by et al., who found it to be valid and trustworthy for gauging students' motivation. The instrument was used since the objective was to evaluate students' motivation for a particular course rather than a broad evaluation of students' motivation [41].

The items are graded on a Likert scale of 1 to 5 points. Participants were asked to select one of five options ranging from 1 to 5 to indicate how strongly they agreed or disagreed with each statement. The survey was translated from English to Persian to prevent misunderstanding or misinterpretation. The original survey's dependability coefficient (Cronbach Alpha) is 0.96. This version of IMMS was found by Kutu and Sözbilir [46] to be valid and reliable to use, making it a suitable instrument for researching the impact of instructional components on learner motivation [46].

The questionnaire application's statistical findings are shown in Table 8, together with measures of central tendency, and variability. Results indicate that every answer is upbeat (close to or more than 4 on a 5-point Likert scale). Examining the negative skewness of items 1, 2, 3, 5, 7, 8, 10 and 12, more respondents have lower assessments than the mean result compared to the number of respondents who offered higher scores. Conversely, items 3,5 and 9 which are low but positive skewness indicates that compared to those who gave it a low assessment, more respondents assessed the item more positively than the mean results. These findings are shown in Tables 9 and 10 given that the means are generally quite considerable. Additionally, an increase in students' motivation of using Google Docs in comparison to conventional vocabulary acquisition techniques on ESP children was compared using a one-sample T-test.

Based on the results of the survey, participants defined the use of Google Docs for ESP instruction. The results demonstrate that all respondents agreed that the quality of the course material helped keep their attention (mean = 4.24, SD = 1.21). The majority of them agreed that the arrangement of the information increased their attention (mean = 4.14, SD = 0.87). However, fewer participants believed that the variety of reading passages, exercises, illustrations, etc., helped keep their attention

(mean = 3.86, SD = 0.90) Furthermore, the association between the course content and what they already knew was evident to them (mean = 3.98, SD = 1.27). The majority of respondents did not collaborate to achieve the goal of having the course's content and writing style convey the impression that the content is worth knowing.

Most of the respondents did not work together to achieve the aim that the content and style of writing in the course express the impression that the content is worth noticing. (mean = 3.96, SD = 0.92). Most of the ESP learners were in agreement with the usefulness of the content of the course material (mean = 4.31, SD = 1.30). On the other hand, few respondents were unanimous that they were confident to learn from the content, as they worked with the course material (mean = 3.95, SD = 0.93), Nonetheless, after studying the educational material, they were self-assured in their ability to complete the course successfully. (mean = 4.03, SD = 1.13). In addition, a few of them were consistent in their belief that the foundation of the content made them more confident in their ability to acquire the course material. (mean = 3.87, SD = 1.09). Most of the respondents contend that, the course material was so enjoyable to them, that they were so eager to comprehend more about the topic (mean = 3.92, SD = 0.99). To boot, the course material was enjoyable to them (mean = 3.96, SD = 1.10). At last, most participants in the experimental group stated that, the course was so well designed that the learners get pleasure from studying in this way (mean = 4.20, SD = 0.87).

Table 8: Descriptive Statistics

Item	Mean	Mode	Median	Standard deviation	skewness	Kurtosis
1	4.2450	5.0	5.0	1.21412	-1.794	2.937
2	4.1460	5.0	4.0	0.87871	-1.479	-0.812
3	3.8618	4.0	4.0	0.90934	-1.356	2.615
4	3.9839	5.0	5.0	1.27429	0.284	0.373
5	3.9689	4.0	4.0	0.92576	-1.034	1.686
6	4.3194	5.0	4.0	1.30380	0.328	0.386
7	3.9506	4.0	4.0	0.92736	-1.368	1.647
8	4.0325	5.0	5.0	1.13981	-0.347	-0.672
9	3.8754	5.0	4.0	1.09536	0.362	-0.903
10	3.9215	5.0	4.0	0.99016	-0.494	-0.928
11	3.9605	5.0	4.0	1.10163	0.382	-0.540
12	4.2001	4.0	4.0	0.87428	-1.202	1.627

Table 9: One-Sample Statistic

N	Mean	Standard deviation	Standard error mean
12	4.00	0.1723	0.689

Table 10: One-Sample T-test

T	Df	Significance, 2-tailed	Mean difference	95% confidence interval of the difference	
				Lower	Upper
58.722	5	0.000	4.000	3.843	4.306

The Effects of Google Docs on learners' perception

Semi-structured interviews with 12 members of the experimental group who had been using the Google Docs website to learn ESP vocabulary were conducted to collect qualitative data. With the help of thematic analysis, we set out to analyze data based on student feedback to provide improvised guidance on strengths and weaknesses and to raise awareness among students using Google Docs when learning ESP vocabulary.

The qualitative results of the semi-structured online interview were assessed, and three categories and themes were identified by keyword analysis of transcripts. The first and the third questions formed the first theme of the interview which related to the effects of using Google Docs. The second question organized the second theme which linked to the title of advantages of Google Docs over the traditional methods of learning. Finally, last but not least theme was drawbacks and recommendations which was represented in question number four of the interview. The detailed evaluation of categories related to the themes are presented in percentage in the following table.

According to the outcome of the first interview question which was: "From your point of view is using Google Docs an efficient website for learning vocabulary? Why?" Google Docs was found to be motivating, creating a competitive atmosphere, and increasing learning vocabulary capacity. In compliance with the results of the third question which was: "From your perspective did Google Docs increase your motivation in the process of learning vocabulary?" It is possible to conclude that, not only do learners find Google Docs motivating and competitive, but also, they came to realize that they could remind the researcher's target vocabulary. They also expanded their nursing vocabulary, which they were unfamiliar with previously.

Based upon the result of the second interview question which was: "What are the benefits of using Google Docs over traditional methods in learning vocabulary?" Analyzing the responses resulted from interviewees mentioned flexibility, Expressing Individual Progress. Yet, it has a lower frequency when compared to the other advantages of Google Docs over traditional methods; some learners emphasized the importance of this feature, as they receive their scores instantaneously after making progress. Almost all students mentioned the importance of accessibility.

Table 11: Interview Categories Related to the Themes

Theme	Category 1	Percentage	Category 2	Percentage	Category 3	Percentage
1	Motivating	75	Creating Competitive Atmosphere	58.3	Increasing Learning Vocabulary Capacity	83.3
2	Flexibility in Learning	91.7	Expressing Individual progress	66.7	Easy and Accessible	83.3
3	Offline mode is preferable	66.7	Gaming mode is preferable	58.3	Visual item is preferable	66.7

The fourth and final question in the online semi-structured interviews seeks responses on the limitations of Google Docs and has recommendations that interviewees make to improve its efficiency. Seven people believe that having access to games while practicing is preferable. Another drawback of Google Docs, according to 8 of the participants, is the absence of visual things since associating a word with a visual item makes it easier for the mind to remember, which improves the lifespan of technical vocabulary. Altogether, All the observation reports about the application of Google Docs, by the interviewed students were positive.

Discussion

Students' attitudes toward the Google Docs online website were positive, and they valued learning through this website. After rehearsing and learning target vocabulary on Google Docs, they felt a feeling of preparedness for nursing English lessons. Furthermore, since they were unfamiliar with the nursing specialized vocabulary at the start of the semester, and a large number of the words were difficult to learn and would require much more effort to memorize them, learners stated that they would continue to use Google Docs online website in their vocabulary learning process. Notwithstanding, another advantage of Google Docs is not only it gives learners a valuable perspective, but also makes the process of training and learning time shorter and easier for the students.

In addition, the students liked how they could practice vocabulary at their own pace without feeling rushed, and how they could use different modes of Google Docs to see the same words over and over again in digital flashcards. This technique improves the memory and ability to respond quickly of students as well as effectively use technical vocabulary [47]. The results of this study are similar to the findings of a study conducted by Lai, Lin, Lin, and Tho. They found that using digital flashcards for teaching vocabularies, considerably enhanced the learners' vocabulary capacities and knowledge [48].

Besides, Researchers of this study concluded that integrating ICT skills into education would increase students' motivation. Several studies can be found in the literature on the effects of technology use and educational motivation, and the results are relevant to this study. Huang and Hew found out that students' level of motivation enhanced when technology was incorporated into instructional design. Their study used widely available online courses as research material and provided a positive motivation for the appearance of ARCS-based elements in IMMS questionnaires [49]. Furthermore, the results of the study were in agreement with Setiawan and Wiedarti, which was admitted that ICT applications for learning vocabulary were not bored easily and they were eager and more motivated, and interested in learning independently [50].

The final research question looked into how experimental group students perceived learning ESP vocabulary using the Google Docs service. The results of the online semi-structured interview revealed that learners found that Google Docs is very stimulating and useful for maintaining vocabulary. Furthermore, learners found the Google Docs online website to be more effective and practical than the traditional teaching methods used for years to learn and practice vocabulary. Findings of Khalil were parallel to our findings. They argued that the Google Docs website has many advantages, such as flexibility, practicality, accessibility, and a competitive

environment that encourages more learning than ever before. In summary, Google Doc was viewed as a practical and helpful online website that learners should use in the future for vocabulary learning processes [51].

Overall, Google Docs improved ESP students' nursing vocabulary learning and practice. The findings showed that this website empowered students to learn and practice technical vocabularies without the aid of the instructor and give them a sense of achievement. Previous studies by various researchers have confirmed the results of the current study [52, 53] which support the present findings in that they all, much like the present study, emphasized on motivational effect of learning ESP through technology. Last but not least, our findings confirm Bilová's conclusion that affirm that Google Docs is one of the efficient tools for learning vocabulary, since it can be a collaborative and individual learning facilitator. So, it is necessary for a teacher to plan carefully for which purposes they are going to use them [14]. Our findings confirm this finding, since, educators should have careful plans during the treatment to get the best result. According to Baicheng, using instances of sentences in vocabulary learning promotes learners' vocabulary gain and retention, as well as enhanced data processing and slowing the rate of memory fading. However, they concluded that students' English proficiency is also important. They demonstrate that weak students had difficulty finding an illustrative example sentence, and their sentence choice frequently indicated that they were unable to comprehend the word itself [54]. The current study used intermediate students to ensure that they had no prior vocabulary knowledge, but with meticulous preparation and the use of technology-enhanced language learning theory as well as the Cloud computing model, which is a model for offering easy, instantaneous network access [22], we were able to achieve the best results.

Finally, because of the first part of the pre-test evaluation, all learners in this study had access to smartphones as well as an internet connection. According to some studies, however, integrating ICT in language classes can be an incentive for those without access to technological resources. As a consequence of these initiatives that have been carried out around the world, a number of schools have been equipped with ICT, and their technological abilities have grown. There are issues, such as a lack of technical support for technologies integrated into learning environments, as well as a lack of educational software and educational materials to use with these advances in technology [55]. Muslem et al. examined the perceptions and limitations of ICT use among Indonesian English educators and concluded that challenges include a lack of equipment, insufficient training for teachers, and teachers' absence of technological understanding [56]. According to Emre, numerous educators have not used modern technology in their classrooms due to a lack of time, expertise, and passion [57].

Conclusions

In conclusion, considering the impact of learning vocabulary by Google Docs online website revealed that this website works as a highly effective tool which supports ESP students and enables them to expand their vocabulary and effectively engage their vocabulary learning. Moreover, contrasted with different strategies for vocabulary learning, not only does Google Docs provide more learning opportunities and more independence to learners, but also, teachers are able to get more

response and perception into learners acquiring. Furthermore, both teachers and ESP learners can get benefit of findings of this study as their learning guidelines. Students can improve their vocabulary autonomously in a shorter period of time. In addition, technology products developed by students can be used to enhance interaction and learner-centered learning. Also, ESP instructors can benefit from CALL in the classes, in face they have more insight on students and also, using innovative instruments help them to be more updated.

Finally, the findings of the study could be useful to ESP material developers. In fact, incorporating ICT into ESP education has revolutionized and altered the way ESP material developers create ESP materials. The consequences of ICT collaboration with ESP instruction have implications for language teaching. Indeed, the findings could aid in the transition from traditional ESP teaching and methods that place an overabundance of emphasis on text comprehension and memorizing vocabulary, which prepares students for communicative applications of ESP. As a result, the findings can be applied to any educational context as well as other languages.

The major limitations of this study are the lack of male participants as well as small sample size. In reality, the most significant limitation is that the results of this research are limitations in obtaining a large sample size.

Ultimately, a number of recommendations for further investigation are given in light of this study's findings. First, it's crucial to look into how students perceive using Google Docs to learn vocabulary in order to learn ESP vocabulary because the study's results showed that doing so significantly increases ESP learners' vocabulary knowledge. Furthermore, since teachers and students hope about the future of ICT in ESP teaching and learning, it can thus be suggested that further studies focusing on the perception of teachers. In general, the study's findings support the use of Google Docs for vocabulary learning, but adjustments to vocabulary design are also required, and additional research with bigger sample numbers is advised.

Authors' Contribution

Zahra Cheraghi, Hengameh Omranpour and Atiye Motaharinejad made a significant contribution to the research presented in the manuscript. However, some parts of the literature review section were written by Fatemeh Moghisseh for the first draft. Expressly, the extended version of the current research was done by the contribution of the first three authors.

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Conflict of Interest

There was no conflict of interest among the authors.

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AUTHOR(S) BIOSKETCHES

Cheraghi, Z. Assistant professor, General Linguistics, Shahid Rajaee Teacher Training University, Tehran, Iran. Her areas of interest include Syntax, Semantics and ESP/EAP.

Cheraghi, Z., Assistant Professor of General Linguistics, Department of English, Shahid Rajaee Teacher Training University
z.cheraghi@sru.ac

Omranpoor, H. is an MA student of TEFL at English Department of Shahid Rajaee Teacher Training University.

Omranpoor, H. English Teacher, MA in TEFL, Shahid Rajaee Teacher Training University, Tehran, Iran.
Omranpour@yahoo.com

Motaharinejad, A. is an MA student of TEFL at English Department of Shahid Rajaee Teacher Training University.

Motaharinejad, A. English Teacher, MA in TEFL and Physical Chemistry, Shahid Rajaee Teacher Training University, Tehran, Iran.
Negar.motaharinejad@gmail.com

Moghisse, F. is an MA student of TEFL at English Department of Shahid Rajaee Teacher Training University.

Moghisse, F. English Teacher, MA in TEFL, Shahid Rajaee Teacher Training University, Tehran, Iran.
Fatememoghisseh@gmail.com

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ORIGINAL RESEARCH PAPER

Identifying and explaining the skills of academic staff members for virtual education in post-Corona: Providing a conceptual model

A. Fazel*, A. Harandi

Business Management Department, Baft Higher Education Center, Shahid Bahonar University of Kerman, Kerman, Iran

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* Corresponding author
amir.fazel@uk.ac.ir
(+98936) 6026310

ABSTRACT

Background and Objectives: The use of digital technology for teaching and learning has been discussed for decades, but now and in the post-Corona era, due to the problems of the COVID-19 pandemic, it has become the focus of many educational institutions. The effect of COVID-19, in a short period, brought about a huge change in the way of education and learning and even completely blocked some educational activities. As a result, education administrators have turned to other alternatives to replace face-to-face or traditional learning. Virtual education is one of the very important and serious programs proposed and carried out by educational institutions in that era, now and in the post-Corona period. The quality of designing and providing virtual education, like face-to-face education, depends on several inputs such as the teacher, learner, technological tools and education design, financial resources system, educational policies, and so on. Among the listed factors, the lecturers of these courses are of special importance. Therefore, according to the change in the teachers' role, their previous skills can no longer be answered, and teachers, in addition to acquiring the necessary skills in the traditional learning environment, need empowerment in various fields, which is the most important step in achieving this important identification. Today, few universities can improve and develop without providing training courses to empower their faculty members, and this is doubly important in the post-Corona period when universities place a lot of emphasis on virtual education. This is because in the Corona and post-Corona period the emphasis on virtual education in higher education and increasing its use, requires special knowledge, skills, and abilities for professors To achieve this, identifying the skills of lecturers in virtual education, it seems essential and paying attention to these skills will lead to the growth of professors and as a result, improve the quality of virtual education. In particular, there is no significant study for the post-Corona period in the context of the research topic, and there is no study on identifying and explaining the teaching skills of teachers for virtual education using the methods of content analysis and fuzzy Delphi. Therefore, the present study aims to identify and explain the skills of academic staff members in virtual education in the post-Corona period in a precise manner using the approaches of content analysis and fuzzy Delphi and presenting a conceptual model.

Materials and Methods: This research is an applied and descriptive research and the combined research methods of interview, content analysis, and fuzzy Delphi were used to collect and analyze information. The statistical population of the research is 20 experts and professors of the Shahid Bahonar University of Kerman. Data were collected through in-depth and semi-structured interviews. Then, all the interviews were analyzed with the method of content analysis, and the skills were extracted and identified. Then, skills were refined and explained in four survey stages using the fuzzy Delphi method.

Findings: In the interview with the experts, two main questions were used to measure the skills and competencies of academic staff members for virtual education in the post-Corona period. The results of the qualitative section included 452 initial codes, which were reduced to 31 main codes and five main categories after data reduction and merging overlapping terms. These five main classes include moral-social, technical-technological, educational-learning, individual-managerial, and supervisory-supportive skills. Then, with a questionnaire, 31 identified skills were examined for refinement and confirmation in four stages. By examining the skills, the experts approved all of them with the fuzzy Delphi approach.

Conclusions: In this study, it was determined that 31 skills are considered for virtual education teachers. In the meantime, we can safely say that 12 skills of social facilitation and appropriate counseling, conflict management, professional and ethical commitment, strategies and applications of learning theories, scholarly and research skills and knowledge sharing, skills to facilitate the teaching process, online lectures, encouraging and motivational skills, administrative and operational organizational skills, maintaining communication with students after completing the course, feedback, and monitoring learning activities, which were approved in the first round of the fuzzy Delphi method, are the most important skills of virtual education. Therefore, more emphasis should be placed on these skills in the post-Corona era in virtual courses.

NUMBER OF REFERENCES
57

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3

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5

مقاله پژوهشی

شناسایی و تبیین مهارت های اعضای هیئت علمی جهت آموزش مجازی در دوره پسا کرونا: ارائه یک الگوی مفهومی

امیر فاضل*، آزین هرندی

گروه مدیریت بازرگانی، مجتمع آموزش عالی بافت، دانشگاه شهید باهنر کرمان، کرمان، ایران

چکیده

پیشینه و اهداف: استفاده از فناوری دیجیتال برای آموزش و یادگیری، دهه ها مورد بحث قرار داشت، امّا اکنون و در دوره پسا کرونا، به دلیل مشکلات دوران همه گیری کوید۱۹، در کانون توجه بسیاری از نهادهای آموزشی قرار گرفته است. تأثیر کوید ۱۹، در کوتاه مدت، شیوه تحصیل و یادگیری را با تحول عظیمی روبروکرد و حتی برخی از فعالیت های آموزشی را کاملا مسدود کرد. در نتیجه متولیان امر آموزش، به جایگزین های دیگری برای یادگیری حضوری یا سنتی روی آوردند. از برنامه های بسیار مهم و جدی که از سمت نهادهای آموزشی و در آن دوران و در حال حاضر و دوره پسا کرونا مطرح و انجام می شود، استفاده از آموزش مجازی است. کیفیت طراحی و ارائه آموزش مجازی مانند آموزش حضوری به دروندادهای متعددی از قبیل مدرس، یادگیرنده، ابزارهای فناورانه و طراحی آموزش، نظام منابع مالی، سیاست های آموزشی و نظایر آن بستگی دارد. از میان عوامل برشمرده، مدرسان این دوره ها دارای اهمیت ویژه ای هستند. بنابراین با توجه به تغییرنقش مدرسان، مهارت های قبلی آنان دیگر نمی تواند پاسخگو باشد و مدرسان علاوه بر کسب مهارت های لازم در محیط یادگیری سنتی، نیازمند توانمندسازی در زمینه های مختلفی هستند که مهم ترین گام در دستیابی به این مهم شناسایی مهارت های مدرسان در زمینه آموزش مجازی است. امروزه کمتر دانشگاهی قادر است بدون ارائه دوره های آموزشی برای توانمندسازی اعضای هیئت علمی خود بهبود و توسعه یابد و این امر در دوره پسا کرونا که دانشگاه ها تاکید بسیاری بر آموزش مجازی دارند، از اهمیت دو چندانی برخوردار است. این بدان دلیل است که در دوره کرونا و پسا کرونا و تاکید بر آموزش مجازی در نظام آموزش عالی و افزایش کاربرد آن نیازمند دانش، مهارت و تواناییهای ویژه ای برای اساتید می باشد، که برای دستیابی به این مهم شناسایی مهارت های مدرسان در آموزش مجازی ضروری به نظر می رسد. توجه به این مهارت ها سبب بالندگی اساتید و در نتیجه بهبود کیفیت آموزش مجازی خواهد شد. به ویژه آن که مطالعه قابل ذکری برای دوره پسا کرونا و در زمنیه موضوع تحقیق مشاهده نشد و بارویکردهای تحلیل محتوا و دلفی فازی مطالعه ای در مورد شناسایی و تبیین مهارت های آموزشی مدرسان جهت آموزش مجازی وجود ندارد. بنابراین هدف مطالعه حاضر، شناسایی و تبیین مهارت های اعضای هیئت علمی در آموزش مجازی در دوره پساکرونا به صورت دقیق و با استفاده از رویکردهای تحلیل محتوا و دلفی فازی و ارائه یک الگوی مفهومی می باشد.

روش‌ها: این پژوهش کاربردی و توصیفی است و برای جمع آوری و تجزیه و تحلیل اطلاعات از روش تحقیق ترکیبی مصاحبه، تحلیل محتوا و دلفی فازی استفاده شده است. جامعه آماری تحقیق جهت مصاحبه، روش تحلیل محتوا و دلفی فازی ۲۰ نفر از خبرگان و اساتید دانشگاه شهید باهنرکرمان می باشند. داده ها با مصاحبه عمیق و نیمه ساختار یافته جمع آوری شد. سپس با روش تحلیل محتوای قراردادی کلیه مصاحبه ها بررسی گردید و مهارت های اعضای هیئت علمی جهت آموزش مجازی در دروه پسا کرونا استخراج و شناسایی شد. سپس در ۴ مرحله نظرسنجی و با استفاده از روش دلفی فازی مهارتها پالایش و تبیین شدند.

یافته‌ها: در مصاحبه با خبرگان با دو سوال اصلی مهارت ها و یا شایستگی های اعضای هیئت علمی جهت آموزش مجازی در پسا کرونا سنجیده شد. نتایج حاصل از بخش کیفی شامل ۴۵۲ کد اولیه بود که بعد از کاهش داده ها و ادغام عبارات همپوشان به ۳۱ کد اصلی و ۵ طبقه اصلی کاهش یافت. این ۵ طبقه اصلی شامل مهارت های اجتماعی-

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آموزش مجازی
نیازها و مهارت های اعضای هیات علمی
پسا کرونا
تحلیل محتوا
دلفی فازی

* نویسنده مسئول
Amir.fazel@uk.ac.ir
۰۹۳۶-۶۰۲۶۳۱۰

اخلاقی، فنی- فناوری، آموزشی- یادگیری، فردی- مدیریتی، ونظارتی- حمایتی می باشد. سپس با پرسشنامه ۳۱ مهارت شناسایی شده جهت پالایش و تایید و در ۴ مرحله مورد بررسی قرار گرفت. خبرگان با بررسی مهارت ها، همه آن ها را با رویکرد دلفی فازی مورد تایید قرار دادند.

نتیجه‌گیری: در این مطالعه مشخص شد که ۳۱ مهارت برای مدرسین آموزش مجازی مد نظر می باشد که دراین بین می توان گفت که ۱۲ مهارت تسهیلگری اجتماعی و مشاوره مناسب، مدیریت تعارض، تعهدحرفه ای و اخلاقی، راهبردها و کاربردهای نظریه های یادگیری، مهارت دانشوری و پژوهشی، مهارت تسهیل فرایند آموزش، سخنرانی برخط، مهارت تشویقی و انگیزشی، مهارت سازمانی و عملیاتی، حفظ ارتباط با دانشجو پس از اتمام دوره، بازخورد، و نظارت بر فعالیتهای یادگیری، که در همان دور اول روش دلفی فازی تایید شدند، مهم ترین مهارت‌های آموزش مجازی می‌باشد و بنابراین باید براین مهارت ها در دوره های مجازی پسا کرونا تاکید بیشتری گردد.

Introduction

One of the serious needs of life in today's fast-paced era, where the volume and speed of changes and transformations during human life are unprecedented, is to shape educational changes and innovations, especially at the level of education in universities and higher education institutions [1]. Because this is one of the most effective areas that enable us to reduce our distance with global developments [2].

The use of digital technology for teaching and learning has been discussed for decades [3], but now due to the Corona era, it has been at the center of public and political attention [4]. Since January 2020, there has been a sudden crisis in the public health of the world, which has spread from the city of Wuhan in China to the whole world and has become a serious threat to humanity [5]. According to the Center for Disease Control, this has been one of the most important and unpredictable global public health crises in recent times [6]. Due to its high transferability, imminence, and invisibility, the global village faced a great challenge [7]. Corona disease has been a major health concern during the last two years and continues to affect people's daily lives [8]. Governments and public health systems, by declaring a state of emergency, have taken extensive measures to prevent this disease, but the stress caused by this disease, and its psycho-social destructive effects severely affect society in every area, especially since it has faced many problems in the field of education [9]. The emergence of COVID-19 has not only negatively affected health issues, but also stopped many economic, educational, and cultural activities around the world [10-11]. The impact of COVID-19, in the short term, brought a strange and huge change to the way of education and learning and even completely blocked the spread of some educational activities [12]. As a result, the guardians of education turned to other alternatives to replace the face-to-face or traditional learning model [13]. One of the very important and serious programs that were proposed and carried out by educational institutions during this period and after that was to switch to virtual education [14].

It should be noted that virtual education was a turning point in the Corona era, and it passed its test well. Of course, despite the continuity of the disease, attention to virtual education and desired competencies should be continuous. This continuation of the approach in the education system requires government investment and the cost of this action is significant, but currently and considering the long-term effects of these changes and the passing of that very difficult period and stepping into the post-Corona period, the educational systems various try to allocate resources, and in some cases invest using innovative procedures and tools and check various preparations and competencies from infrastructure and structure

to content and teachers. Provide appropriate educational services, provide adequate support, and maintain their readiness [2].

Currently, with the control of the Coronavirus epidemic, as well as opportunities and challenges such as the introduction of information and communication technologies, and increasing access to technology in higher education, universities facing an increase in demand for education, the need for economic activities to provide new resources, and the application of information technology to provide education services in the global market, which already existed, has caused universities to reconsider their traditional roles and create new educational structures [15-19].

The result of this structural change is the creation of a new model of the teaching-learning system under the name of virtual education. In a general definition, virtual education is the use of network technology (for example, the Internet) to design, deliver lessons, and implement the educational environment to realize and continue learning [20]. Also, Kamalian and Fazel in their definition of virtual education, which seems to be more comprehensive than other definitions, considers virtual education to consist of four dimensions. They state that virtual education can be both an individual activity and a group activity. At the same time, in addition to these two dimensions (i.e. individual and group study), virtual education is both continuous (simultaneous communication) (communication with learning resources and with people simultaneously and in a real way) and discrete (asynchronous communication) (with the use of educational CDs that have already been prepared or through educational materials that have already been downloaded from the Internet [21]. In fact, virtual education consists of two broad sets (Information Technology) and (Education and Research) [22].

This method of education is considered an important tool in higher education in the digital age and has caused the creation of a learner-based learning environment, flexibility in learning methods, and the introduction of changes in the teaching-learning process in the higher education system [23]. In fact, virtual education, by applying the latest achievements of the era of information and communication technology, has created new approaches [24], and has provided clear horizons in the field of higher education [25].

The quality of designing and providing virtual education, like face-to-face education, depends on several inputs such as the teacher, the learner, technological tools, education design, financial resources system, educational policies, and so on [26-27]. Among the listed factors, the lecturers of these courses are of special importance [28].

Based on the constructivist approach in the teaching-learning process, the role of the lecturer has changed from a mere speaker in a traditional classroom environment, whose task is only to convey the message to students through educational media, to a guide of learning activities [29]. In fact, the instructor guarantees the quality of virtual learning by managing motivation, supporting students, and helping them to understand the content [30]. Therefore, according to the change in the teacher's role, his previous skills can no longer be answered, and teachers, in addition to acquiring the necessary skills in the traditional learning environment, need empowerment in various fields, which is the most important step in achieving this important identification. The skills of lecturers and faculty members are in the field of virtual education [31] and it is currently in the post-Corona period .Today, few universities can improve and develop without providing training courses to empower their faculty members, and this is doubly important

now that universities place a lot of emphasis on virtual education and this is the reason that in the period of Corona and post-Corona, and the emphasis on virtual education in the higher education system, and increasing its use, requires special knowledge, skills, and abilities for teachers, who, to achieve this, identify the skills of teachers in virtual education seem necessary, and paying attention to these abilities will lead to the growth of teachers, and as a result, the quality of virtual education will improve.

The post-coronavirus situation shows that virtual education has become one of the infrastructures of universities. Continuation of this process causes ambiguities and the lack of accurate and correct conclusions about the skills needed by teachers for virtual education, and it may confuse those involved in the educational system regarding these skills in the educational system. Therefore, the best way to achieve these skills is a deep study with new approaches such as content analysis and fuzzy Delphi. According to what was mentioned, it seems necessary to use these approaches to identify and explain the skills of faculty members for virtual education and to achieve a comprehensive conceptual model in post-coronavirus conditions.

Considering the topic and goals considered, this research is important from three theoretical, practical, and methodological perspectives. From a theoretical point of view, the current study seeks to help identify and explain the skills of faculty members for virtual education, and the theoretical knowledge obtained from this study is theoretically more important than the findings of other studies. From the practical aspect, if in this research the skills of academic staff members for virtual education are identified and explained in the current and post-corona period, it can be done by familiarizing teachers, managers, and stakeholders with the mentioned concepts, and accordingly, The effects of quality virtual learning courses, and using the skills of teachers, on the cognitive, academic and motivational processes of learners, provided the space for increasing the better performance of the beneficiaries of virtual education. In terms of methodology, according to the few studies in the field of identifying and explaining the skills of academic staff members for virtual education, no comprehensive research has been done with content analysis and fuzzy Delphi methods in relation to the subject.

Therefore, the present study aims to identify and explain the skills of academic staff members in virtual education in the post-Corona era in a precise manner using modern approaches of content analysis and fuzzy Delphi and presenting a conceptual model.

Review of the Related Literature

Nikoubakht et al. have defined virtual education as the method of presenting content through digital devices such as computers and mobile phones to improve learning [1]. Unlike face-to-face training in the classroom, in virtual training, everything is easily available, for example, the color of the screen or checking the correctness and accuracy of the content can be done easily [8]. Although many advantages have been mentioned for this educational method such as educational flexibility and student-centered learning [4], improving communication skills between professors and students through daily interactions, improving learning through social interactions within the network such as group discussion and disseminating different information [2]. But other studies have also mentioned challenges and disadvantages: such as being time-consuming, expensive to prepare programs, dependence on the Internet, technical and

financial support problems for program preparation and implementation [32], lack of managerial and supervisory skills, limitations in technical and communication infrastructures, lack of full compatibility of the content provided with existing needs, limitations and damage to social communication skills [7] and low quality of learning and lack of use of trained teachers in the field of virtual education [5].

Several studies have been conducted in the field of professional skills of faculty members, and most of these researches have investigated learning skills in non-virtual learning environments. For example, in one study, it was shown that the most important skills of faculty members are educational skills related to knowledge, skill information, motivation, incentives, and learning environment, and non-educational skills include operational administrative skills and support skills [33]. Kwek and Cheung have proposed in their research that an essential part of teachers' professional development, is knowing how students learn and how to organize an online course to achieve maximum learning. They also emphasize that teachers need coaching and support skills to teach effectively using technology. In fact, in addition to being aware of technical and operational aspects, teachers need to acquire the necessary knowledge in the field of pedagogical skills [34]. Simon emphasizes that an effective internship program should be a combination of different resources such as people, educational materials, and technology; so that the teachers can share their knowledge and expertise as well as their success and failure stories [35]. Levinsen believes that the teacher in the context of e-learning needs technical, educational and communication skills [36]. In this context, Gilzene has listed 11 roles for instructors of virtual education courses in his research, which include technology-savvy educational designer instructor, technician, facilitator, performer, supporter, editor, librarian, evaluation specialist, and graphic designer [37]. The research results of Bornet et al. show that in the e-learning environment, the professional skills of teachers include technical skills, educational competence, and communication skills [12]. Amundsen suggests that faculty development in a general sense is any intervention that aims to provide the necessary opportunities for faculty members to improve their scholarly roles as research scientists as educational researchers, and as teachers [38].

In Gao et al.'s study, two categories of skills were identified for faculty in virtual education. Soft skills, such as student participation, motivating students, enhancing critical thinking, curriculum design, classroom management, crisis management, time management, creating a learning community, creating discussion and dialogue forms, and technical skills such as using technology in general, creating content Interactive using multimedia tools, expressions of learning system management, using tools to create teaching opportunities [39].

Hajizadeh and his colleagues state that the necessary characteristics for faculty members of the virtual education and learning system include management and encouragement, interaction, support for students, electronic skills and commitment, positive attitude, and facilitation [40]. The results of Sedeghpour and Mirzaei's research show that for the development and implementation of high-quality virtual education courses, there is a skill for teachers' preparation in all social, cultural, economic, and educational dimensions [41]. The results of the research of Daneshwar and Mehr Mohammadi show that the necessary qualifications of virtual education teachers are pedagogical qualifications, technological

qualifications, and the combined qualifications of pedagogic knowledge and technology, which according to the growth and development of electronic education and the increased of electronic learning environments, there is a need to prepare teachers to acquire the above qualifications [42]. In their study, Pourjamshidi and FarDanesh mentioned the factors affecting the interaction between the teacher and the learner in the web-based educational environment, including technical and instrumental skills, communication skills, commitment and order, scientific mastery, motivation and attitude in the field of virtual education [43]. Mehralian and Maghami consider the competencies of an electronic teacher to include 16 components in 8 dimensions social, moral, managerial, individual, teaching skills, supervision, educational commitment, and technology [44].

In general, the review of the research literature indicates that although several studies have been conducted on the skills of teachers for virtual education, but each of these studies has addressed specific aspects and a comprehensive and sufficient study with a qualitative and quantitative approach has not been conducted. In particular, there is no significant study for the post-corona period and in the context of the research topic, and there is no study on identifying and explaining the skills teachers have for virtual education using the methods of content analysis and fuzzy Delphi. In this sense, researchers are trying to examine and explain this issue carefully and accurately.

Method

Since this study seeks to identify and explain the skills of faculty members, and provide a conceptual model for virtual education and present a new plan of information, it is considered applied research. Also, based on the research plan and in terms of data collection, the current research is descriptive research and the combined research methods of interview, content analysis, and fuzzy Delphi were used to collect information. In this research, the contractual content analysis method was used to extract the skills of virtual education from interviews with experts, and the fuzzy Delphi method was used to refine and explain these skills.

The conventional content analysis method is often suitable when the existing theory or research texts and research literature about that phenomenon are limited. In this method, classes and codes flow from the heart of the data. In the mentioned method, the information collected through written texts or interviews and pre-existing theories had no place [45].

Participants

The participants were selected by purposive sampling method. In this method, the researcher used research participants who had rich experience with the research topic. The criteria for entering the study included having the academic rank of assistant professor and above, and teaching experience of at least 8 years, as well as teaching experience during the Corona period and in virtual form. So that the teacher, through the experience of face-to-face training, can accurately and fully express his experiences of the skills of virtual training and the difference between it and face-to-face training. The participants were experienced faculty members of the Shahid Bahonar University of Kerman. It was tried to select experts from both sexes, different scientific ranks, and different fields with different teaching experiences so that the maximum variety of sampling is observed.

Instruments

Data collection was done using semi-structured interviews with open questions. The interviews started with some general questions. Sample interview question: “Please describe your experience of a day of class virtually. In your opinion, what skills should a teacher have for virtual education? What are the competencies of virtual education teachers? Based on the responses of the participants, further follow-up questions in this area such as explain a little more. Please give an example of this, it was asked. The duration of the interviews was 20 to 60 minutes, with an average of 40 minutes. The number of participants was determined based on data saturation. So, after 17 interviews, a new class was not formed, but to be sure, three more interviews were conducted and the final number of participants was 20 people.

Data Analysis

Data analysis was done using conventional content analysis with Graneheim and Lundman method. First, the entire interview text was carefully read to immerse in the data and reach a general understanding. After that, the target text was read several times. Then the semantic units were specified and the primary codes were formed, and these codes were placed in subclasses and classes according to relationships, similarities, and differences [46].
To ensure the accuracy and scientific accuracy of the presented materials, the four criteria of Lincoln and Goba, which include reliability, validity, transferability, and verifiability, were used.

Validity: For this purpose, the researchers tried to communicate with the data and experts over a long period of time, to ensure that the researchers' perceptions are exactly what the participants understood. By collecting valid information and verifying the information from the participants, the researchers tried to increase the validity of their research.

Reliability: For data verifiability, the analyzed interviews were provided to three lecturers who participated in the study. Then, an experienced person who had research experience in the field of virtual education and qualitative research methodology was requested to study the extracted codes and themes from the interviews.

Transferability: The researchers tried to help in the evaluation and applicability of the research in other fields by providing sufficient and detailed explanations about the characteristics of the participants, steps, and work methods

Verifiability: The researchers tried to show evidence for the emergence of the results from the data by keeping the documents related to the different stages of the research. They also used the approval of professors and experts in this department. Also, the statistical population of the research in the fuzzy Delphi section includes 20 experts who were selected for conventional content analysis. They refined the skills extracted from the interviews [47].

The present research questionnaire has been designed, aiming at obtaining the experts’ opinions about the amount of their agreement with competencies and skills. Therefore, the experts have expressed their amount of agreement through verbal variables such as very low, low, medium, high, and very high. Since the different characteristics of individuals influence their mental interpretations of qualitative variables, so defining the scope of qualitative variables, the experts have answered questions with the same mentality. These variables have been defined considering Table 1 and Fig. 1 in the shape of triangular fuzzy numbers.

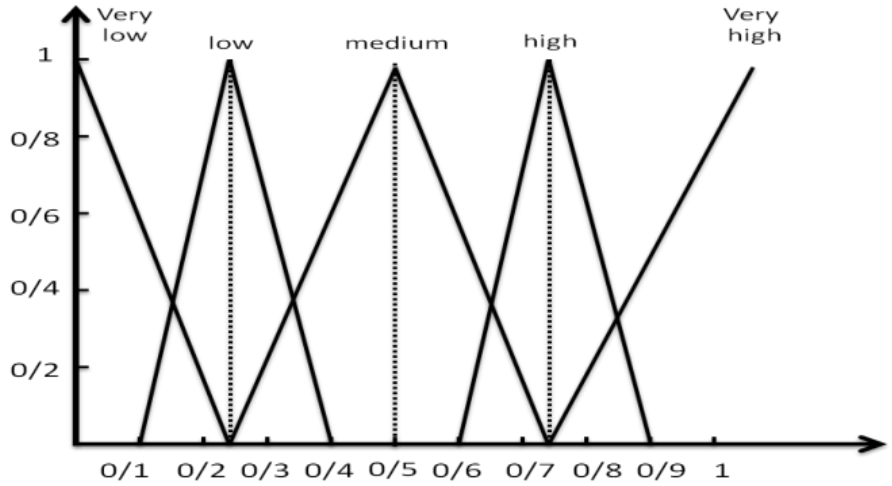

Fig. 1: Triangular fuzzy number of verbal variables

Table 1: Triangular fuzzy number of verbal variables

Verbal variables	Determined fuzzy number	Triangular fuzzy number
Very high	(1,0.25,0)	0.9375
High	(0.75,0.15,0.15)	0.75
Medium	(0.5,0.25,0.25)	0.5
Low	(0.25,0.15,0.15)	0.25
Very low	(0,0,0.25)	0.0625

In above table, the determined fuzzy numbers have been calculated by using Minkowski's formula as following:

Formula (1):

$$x = \mathrm{m} + \frac{\beta - \alpha}{4}$$

With regard to the proposed options and linguistic variables defined in the questionnaire, the results of the investigation of responses presented in Table 3 have been provided. Regarding the results of this table, the fuzzy average of each factor has been calculated according to the following equations.

Formula 2:

$$A_i=(a_1^{(i)}, a_2^{(i)}, a_3^{(i)}), \quad i=1,2,3,\ldots,n$$

Formula 3:

$$A_{ave}=(m_1,m_2,m_3)=\left(\frac{1}{n}\sum_{i=1}^{n} a_1^{(i)}, \frac{1}{n}\sum_{i=1}^{n} a_2^{(i)}, \frac{1}{n}\sum_{i=1}^{n} a_3^{(i)}\right)$$

In this equation, iA indicates the expert's view i, and aveA represents the average of the expert's view. The results of these calculations have been presented in Table 3. The execution algorithm for the Fuzzy Delphi method is illustrated in Fig.2 [48].

Results and Findings

Content analysis method

In this study, the age range of the participants was 39 to 62 years. 80% of the participating teachers were men. The teaching experience of the academic staff varied from 8 to 31 years. In terms of rank, 54% were assistant professors, 24% were associate professors, and 22% were full professors. The academic group of the faculty members was 10 people from the humanities department, four people from the basic sciences, and six people from the technical and engineering departments. The results of the qualitative section included 452 initial codes, which were reduced to 31 main codes and five main categories after data reduction and merging overlapping terms. These five main classes include moral-social, technical-technological, educational-learning, individual-managerial, and supervisory-supportive skills. In Table 2, the dimensions,

and skills of academic staff members for virtual education in the post-Corona era are shown as a result of the content analysis method

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Fuzzy Delphi method

To explain, refine, and confirm the skills of virtual education, which was obtained in the stage before the content analysis approach, the fuzzy Delphi method has been used. The implementation steps of the fuzzy Delphi method are a combination of implementing the Delphi method and performing analyses of information using the definitions of the theory of fuzzy sets [49]. In the current research, 31 skills of virtual education were identified for virtual education with the content analysis method, which were entered into the fuzzy Delphi method for analysis and institutionalization. The following steps are used to implement the fuzzy Delphi approach:

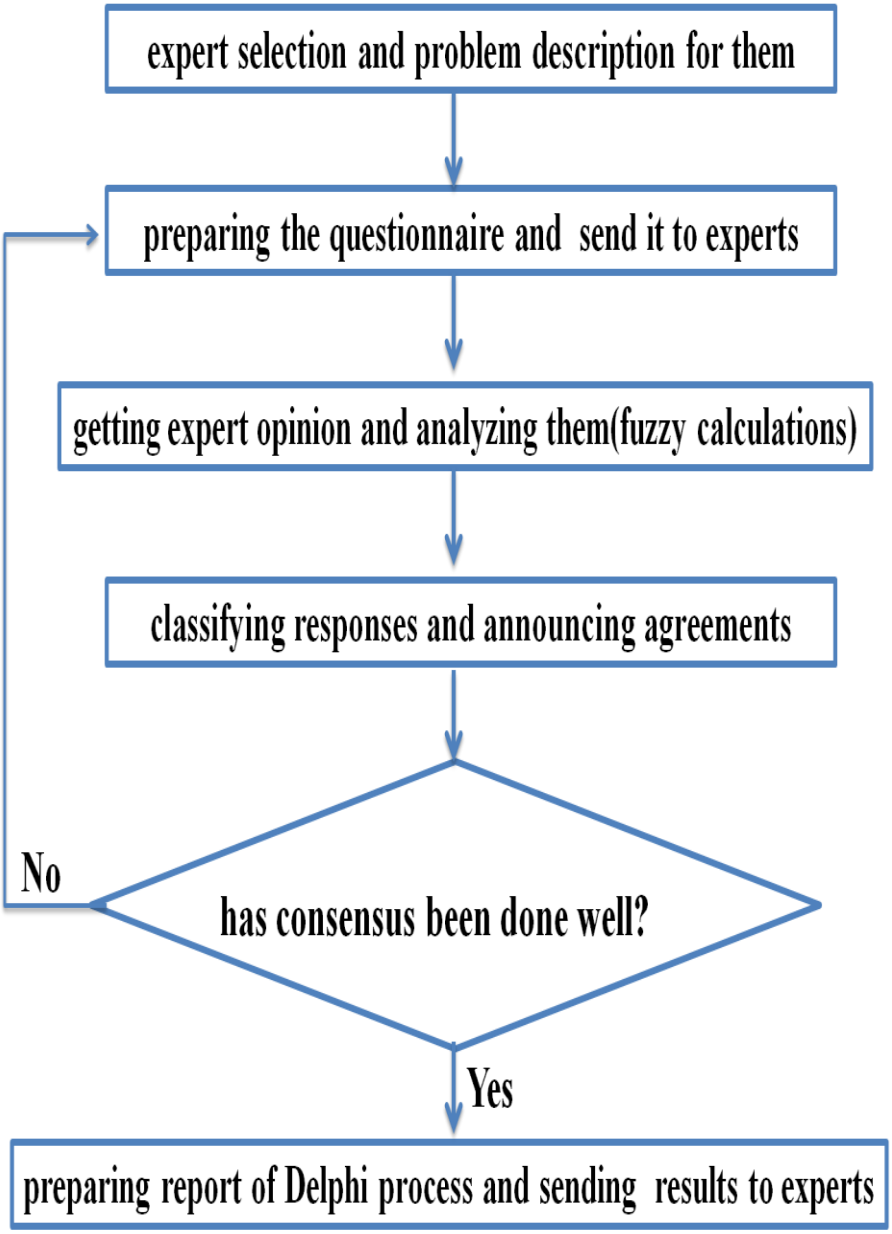

Fig. 2: Delphi technique implementation algorithm

First stage: In this stage, the identified skills were sent to the members of the expert group and their opinions were collected. According to the proposed options and linguistic variables defined in the questionnaire, the results of the examination of the answers are presented in Table 3. According to the results of this table, the fuzzy mean of each of the specified skills has been calculated according to Formulas 2 and 3, and then it has been de-fuzzified using the Minkowski Formula (Formula 1). The absolute mean obtained shows the intensity of experts' agreement with each of the research components. The results of calculations related to the first stage of the fuzzy Delphi method are shown in Table 3.

Table 2: skills of academic staff members for virtual education resulting from the content analysis

Ethical Social	Technical Technology	Educational Learning	Individual Managerial	Supervisory supportive
1.Social facilitation and appropriate counseling 2.Conflict management 3.Professional and ethical commitment 4.Creating motivation for virtual learning 5.Cognitive skill 6.Intercultural skills	7.Technological skills (hardware and software) 8.skill of updating teaching resources and methods 9. Support and solve technical problems 10. Production and presentation of content	11.Strategies and applications of learning theories 12.Teaching skills 13.Educational commitments 14.Educational design and planning 15.Resource identification skills 16.Scholarly, research and knowledge sharing skills 17.The skill of facilitating the training process 18.online lecture	19.The skill of positive attitude towards synchronous and asynchronous teaching 20.Time management and training course management 21.Encouraging and motivational skills 22.Organizational, administrative and operational skills 23.Diagnostic skills (analytical, initiative, creativity) 24.Leadership skills, guidance and guidance of students 25.Crisis management skills	26.Final evaluation and course 27.Maintaining contact with the student after completing the course 28.Feedback 29.Monitoring the learning activities of learners 30.The skill of spiritual and legal support of the input and output of virtual education 31.The skill of encouraging learners to group and self-evaluation

Table 3: Results and level of the experts' agreement

Skills	Very low	low	Medium	high	Very high	m	α	β	X
Social facilitation and appropriate counseling	0	0	0	2	18	0.98	0.24	0.02	0.92
Conflict management	0	0	0	1	19	0.99	0.25	0.01	0.93
Professional and ethical commitment	0	0	0	0	20	1.00	0.25	0.00	0.94
Creating motivation for virtual learning	4	4	4	4	4	0.50	0.16	0.16	0.50
Cognitive skill	0	3	11	1	5	0.60	0.23	0.17	0.58
Intercultural skills	0	0	9	3	8	0.74	0.24	0.14	0.71
Technological skills (hardware and software)	0	0	0	14	6	0.83	0.18	0.11	0.81

Skills	Very low	low	Medium	high	Very high	m	α	β	X
Skill of updating teaching resources and methods	0	0	6	6	8	0.78	0.22	0.12	0.75
Support and solve technical problems	3	0	5	9	3	0.61	0.17	0.17	0.61
Production and presentation of content	0	0	0	15	5	0.81	0.18	0.11	0.80
Strategies and applications of learning theories	0	0	0	0	20	1.00	0.25	0.00	0.94
Teaching skills	0	0	4	1	15	0.89	0.25	0.06	0.84
Educational commitments	0	0	0	18	2	0.78	0.16	0.14	0.77
Educational design and planning	0	5	9	2	4	0.56	0.22	0.17	0.55
Resource identification skills	0	0	0	16	4	0.80	0.17	0.12	0.79
Scholarly, research and knowledge sharing skills	0	0	0	11	9	0.86	0.20	0.08	0.83
The skill of facilitating the training process	0	0	0	5	15	0.94	0.23	0.04	0.89
online lecture	0	0	0	2	18	0.98	0.24	0.02	0.92
The skill of positive attitude towards synchronous and asynchronous teaching	0	0	10	6	4	0.68	0.22	0.17	0.66
Time management and training course management	0	0	6	0	14	0.85	0.25	0.08	0.81
Encouraging and motivational skills	17	1	2	0	0	0.06	0.03	0.25	0.12
Organizational, administrative and operational skills	0	0	13	6	1	0.60	0.22	0.21	0.60
Diagnostic skills (analytical, initiative, creativity)	0	1	11	6	2	0.61	0.22	0.19	0.61
Leadership skills, guidance and guidance of students	0	1	1	18	0	0.71	0.16	0.16	0.71
Crisis management skills	0	0	0	12	8	0.85	0.19	0.09	0.83
Final evaluation and course	0	0	4	4	12	0.85	0.23	0.08	0.81
Maintaining contact with the student after completing the course	0	0	1	0	19	0.98	0.25	0.01	0.92
Feedback	0	0	0	0	20	1.00	0.25	0.00	0.94
Monitoring the learning activities of learners	0	0	7	3	10	0.79	0.24	0.11	0.76
The skill of spiritual and legal support of the input and output of virtual education	1	4	5	8	2	0.58	0.18	0.17	0.57
The skill of encouraging learners to group and self-evaluation	0	0	6	6	8	0.78	0.22	0.12	0.75

Second stage: In this stage, the second questionnaire was prepared and sent to the members of the expert group together with the previous point of view of each person and the extent of their difference with the point of view of other experts. At this stage, the experts did not combine or remove any skill and they answered the questions again according to the opinions of other group members about the goals, the results of which are presented in Table 4 .

The last column of Table 4 shows the difference between the first and second stages of the survey. According to the views presented in the first stage and comparing it with the results of this stage, if the difference between the two stages is between 0 and 0.1, then the survey process will be stopped. In this way and

according to the above table of experts regarding the skills of social facilitation and appropriate counseling, conflict management, professional and ethical commitment, strategies and applications of learning theories, scholarly and research skills and knowledge sharing, process facilitation skills Training, online lectures, encouraging and motivational skills, administrative and operational organizational skills, maintaining communication with students after the course, feedback, monitoring learning activities have reached a consensus and these skills have been approved.

Third stage: In this stage, while making the necessary changes, a third questionnaire was prepared and sent to the experts along with the previous point of view of each person and the difference between them and the average point of view of other experts. The difference is that at this stage, out of the 31 skills available in the previous stage, 12 were stopped and a survey was conducted on the rest of the remaining skills. The survey results are shown in Table 5.

Table 4: Results and the expert's agreement and differences in skills

Skills	Very low	low	Medium	high	Very high	m	α	β	X	Difference
Social facilitation and appropriate counseling	0	0	0	0	20	1.00	0.25	0.00	0.94	0.02
Conflict management	0	0	0	0	20	1.00	0.25	0.00	0.94	0.01
Professional and ethical commitment	0	0	0	0	20	1.00	0.25	0.00	0.94	0.00
Creating motivation for virtual learning	0	0	6	11	3	0.71	0.20	0.16	0.70	0.20
Cognitive skill	0	0	3	12	5	0.78	0.19	0.13	0.76	0.18
Intercultural skills	0	0	0	2	18	0.98	0.24	0.02	0.92	0.21
Technological skills (hardware and software)	0	0	0	1	19	0.99	0.25	0.01	0.93	0.12
Skill of updating teaching resources and methods	0	0	1	6	13	0.90	0.22	0.06	0.86	0.11
Support and solve technical problems	0	0	1	3	16	0.94	0.24	0.04	0.89	0.28
Production and presentation of content	0	0	0	0	20	1.00	0.25	0.00	0.94	0.14
Strategies and applications of learning theories	0	0	0	0	20	1.00	0.25	0.00	0.94	0.00
Teaching skills	3	1	2	0	14	0.76	0.21	0.07	0.73	-0.11
Educational commitments	0	0	0	0	20	1.00	0.25	0.00	0.94	0.17
Educational design and planning	0	0	0	17	3	0.79	0.17	0.13	0.78	0.23
Resource identification skills	0	0	0	0	20	1.00	0.25	0.00	0.94	0.15
Scholarly, research and knowledge sharing skills	0	0	0	1	19	0.99	0.25	0.01	0.93	0.09
The skill of facilitating the training process	0	0	0	0	20	1.00	0.25	0.00	0.94	0.05
online lecture	0	0	0	0	20	1.00	0.25	0.00	0.94	0.02
The skill of positive attitude towards synchronous and asynchronous teaching	0	0	2	12	6	0.80	0.19	0.12	0.78	0.12

Skills	Very low	low	Medium	high	Very high	m	α	β	X	Difference
Time management and training course management	0	0	0	0	20	1.00	0.25	0.00	0.94	0.13
Encouraging and motivational skills	0	0	4	16	0	0.70	0.17	0.17	0.70	0.10
Organizational, administrative and operational skills	1	0	0	8	11	0.85	0.20	0.07	0.82	0.08
Diagnostic skills (analytical, initiative, creativity)	0	0	3	9	8	0.81	0.21	0.11	0.79	0.18
Leadership skills, guidance and guidance of students	0	0	0	2	18	0.98	0.24	0.02	0.92	0.21
Crisis management skills	0	0	0	0	20	1.00	0.25	0.00	0.94	0.11
Final evaluation and course	0	0	0	1	19	0.99	0.25	0.01	0.93	0.12
Maintaining contact with the student after completing the course	0	0	0	0	20	1.00	0.25	0.00	0.94	0.02
Feedback	0	0	0	0	20	1.00	0.25	0.00	0.94	0.00
Monitoring the learning activities of learners	0	0	0	10	10	0.88	0.20	0.08	0.84	0.09
The skill of spiritual and legal support of the input and output of virtual education	0	0	2	10	8	0.83	0.20	0.10	0.80	0.23
The skill of encouraging learners to group and self-evaluation	0	0	0	3	17	0.96	0.24	0.02	0.91	0.16

Table 5: Results and the expert's agreement and differences with skills of stages 2 and 3

Skills	Very low	low	Medium	high	Very high	m	α	β	X	Difference
Creating motivation for virtual learning	0	0	0	4	16	0.95	0.23	0.03	0.90	0.20
Cognitive skill	0	0	0	1	19	0.99	0.25	0.01	0.93	0.17
Intercultural skills	0	0	0	0	20	1.00	0.25	0.00	0.94	0.02
Technological skills (hardware and software)	0	0	0	0	20	1.00	0.25	0.00	0.94	0.01
Skill of updating teaching resources and methods	0	0	0	1	19	0.99	0.25	0.01	0.93	0.07
Support and solve technical problems	0	0	0	0	20	1.00	0.25	0.00	0.94	0.05
Production and presentation of content	0	0	0	0	20	1.00	0.25	0.00	0.94	0.00
Teaching skills	0	2	2	1	15	0.86	0.24	0.05	0.82	0.09
Educational commitments	0	0	0	0	20	1.00	0.25	0.00	0.94	0.00
Educational design and planning	0	0	0	1	19	0.99	0.25	0.01	0.93	0.15
Resource identification skills	0	0	0	0	20	1.00	0.25	0.00	0.94	0.00
The skill of positive attitude towards synchronous and asynchronous teaching	0	0	0	1	19	0.99	0.25	0.01	0.93	0.15
Time management and training course management	0	0	0	0	20	1.00	0.25	0.00	0.94	0.00

Skills	Very low	low	Mediu m	high	Very high	m	α	β	X	Differe nce
Diagnostic skills (analytical, initiative, creativity)	0	0	0	2	18	0.98	0.24	0.02	0.92	0.13
Leadership skills, guidance and guidance of students	0	0	0	0	20	1.00	0.25	0.00	0.94	0.02
Crisis management skills	0	0	0	0	20	1.00	0.25	0.00	0.94	0.00
Final evaluation and course	0	0	0	0	20	1.00	0.25	0.00	0.94	0.01
The skill of spiritual and legal support of the input and output of virtual education	0	0	0	2	18	0.98	0.24	0.02	0.92	0.12
The skill of encouraging learners to group and self-evaluation	0	0	0	0	20	1.00	0.25	0.00	0.94	0.03

According to Table 5 and by comparing the difference with the base number of 0.1, it is clear that the expert group has agreed with the skills of intercultural skills, technological skills, the skill of updating resources and teaching methods, supporting and solving technical problems, content production and presentation, teaching skills, educational commitments, resource identification skills, time management and training course, leadership skills, mentoring and guidance, crisis management skills, final and course evaluation, persuasion skills and group evaluation and self-evaluation. The rest of the targets will enter the next round of the survey.

Fourth stage: In this stage, the fourth questionnaire was prepared and sent to the experts along with the previous point of view of each person and the amount of difference between them and the average point of view of other experts. With the difference that at this stage, only 6 remaining skills have been surveyed.

Based on the output of this stage, the amount of disagreement between the experts in the third and fourth stages was less than the threshold, so the polling was stopped at this stage. According to the results of this stage, the skills of motivation for learning, cognitive skills, educational design and planning, positive attitude to teaching skills, diagnostic skills, and spiritual and legal support skills were also confirmed. In this way, the experts agreed with all the identified skills for the virtual training of the academic staff .Figure 3 shows the conceptual model of the skills of faculty members for virtual education in the post-Corona period.

Discussion

The teaching quality of virtual education depends not only on the existence of advanced technology and multimedia computers and connection to the global network but also on the existence of professors with new qualifications and skills [44]. Improving the teaching-learning process through programs and professional development centers for teachers is one of the goals of higher education centers; In addition, in virtual education environments, due to the change in the role of the teacher, his previous skills can no longer be answered, and in addition to mastering the necessary skills in the traditional learning environment, teachers need skills and expertise in the virtual education environment, such as are technical, technology and expertise in the field of information technology.

Based on the constructivist approach, in the teaching-learning process, the role of the instructor has changed from a mere speaker in

a traditional classroom environment, whose task is only to convey the message to students through educational media, to a guide of learning activities [50]. In fact, the instructor guarantees the quality of e-learning by managing motivation, supporting students, and helping them understand the content; Therefore, due to the change in the teacher's role, his previous skills can no longer be answered and teachers need to be empowered in different fields in addition to acquiring the necessary skills in the traditional learning environment [51].

In the virtual education environment, the role of faculty members is changing from providing information to managing motivation, supporting students, and helping them to understand the content and the necessity of connecting to the network for learning so that they guarantee the quality of virtual education. Teachers need training and support to effectively teach using technology. They need more knowledge than the technical and operational aspects of using technology. The training and support of teachers should address the way of using technology to improve student learning and performance; Merely providing instructors with software and other technological tools does not guarantee that they can effectively use those tools to help students learn. Teachers need training that gives them the skills to produce and use pedagogically perfect educational materials suitable for online education [25].

The skills presented in this research, and the model presented, enable instructors to manage the synchronous and asynchronous virtual environment, manage communication channels and files that are shared in it. In other words, in the post-corona era, virtual education teachers should have social, moral, managerial, personal, teaching, supervisory skills, educational and technological commitment. Considering the need to strengthen the human infrastructure of virtual education, it is suggested that senior managers and those in charge provide suitable grounds for using the mentioned model and the results of this research to train and develop the skills of faculty members for virtual education and accordingly, improve the quality of virtual education. This model can be used in designing career development programs, determining training skills in future courses and modifying the learning management system, and compiling the best features needed for instructors in virtual education. Using this skills assessment, it is possible to choose suitable training areas and design appropriate activities to create optimal virtual education with an emphasis on the skills of teachers.

Although the spread of Corona disease was terrible in various fields, it seems that it was a blessing in the field of education to be able to force teachers into virtual education; Therefore, this form of education should be strengthened by providing comprehensive in-service courses, with the titles of effective virtual education instructor, or the competencies and skills required for virtual education. The different nature and role of faculty members for effective teaching in virtual environments has highlighted the necessity of equipping lecturers with teaching, social, and cognitive skills. Thinking about the results of the existing research for teaching in virtual education with fewer restrictions, you should choose professors for teaching who, in addition to having teaching skills and capabilities, are also proficient in electronic skills and capabilities, and are able to manage the virtual environment. Due to the existence of important challenges in the field of virtual education in the country, it is necessary to use capable and committed teachers in the virtual education of universities, because part of the above challenges are related to professors and

lecturers and if he has sufficient mastery in using the facilities and tools available in the virtual classroom and the educational system, the limitations of such training that are related to professors and lecturers will be removed to a large extent.

Finally, today, due to the development of Internet technologies, and the existence of huge challenges during face-to-face education such as the Coronavirus, universities cannot ignore virtual education. Virtual teaching has become an unavoidable part of higher education and the use of its capabilities is recommended for most educational systems and institutions. But in the meantime, and now and in the post-corona period ,it is necessary to have a correct understanding of the realities, conditions, and competencies in the implementation of virtual education. Knowing the weaknesses and strengths, threats and opportunities and examining the competencies and skills in the environment where virtual education is going to be established, as well as examining issues such as ethical, social, technical, technological, educational, learning competencies, individual, managerial, supervisory, and support, especially in university faculty members, as the front line of virtual education, will guarantee the success of such a system. What was done in this research was to understand part of the existing conditions and examine the importance of academic faculty members' skills for virtual education in the post-Corona period, and present a conceptual model based on, and it was concluded that these academic faculty members' skills are very important for implementing virtual education. Fig. 3 shows the conceptual model of the skills of faculty members for virtual education in the post-Corona period.

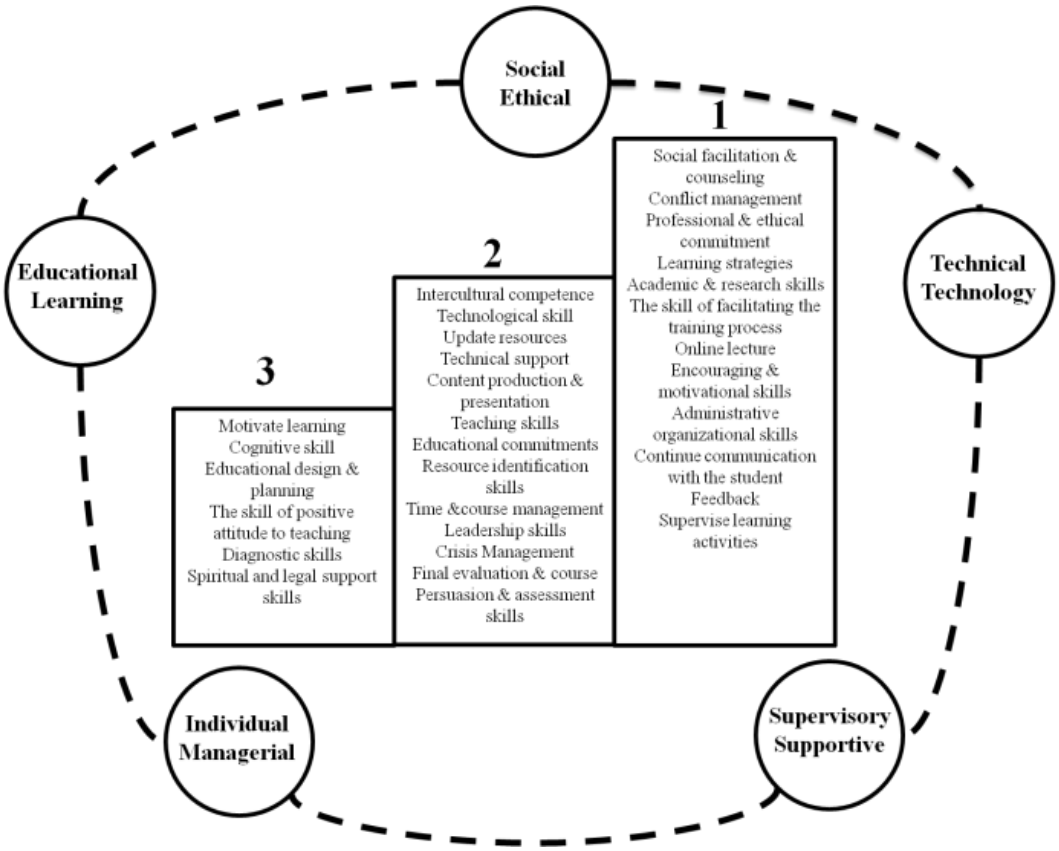

Fig. 3: Conceptual model of faculty members skills for virtual education in the post-corona era

Conclusions

Considering the lack of comprehensive and sufficient studies on the skills of academic staff members for virtual education, in the research conducted, it was tried to use semi-structured interviews, and with the approach of content analysis, all the skills of teachers were identified. Then, experts' opinions and the fuzzy Delphi method were used to clarify and refine all these skills. According to the study conducted based on the content analysis method, 31 skills were identified for this virtual training. The identified skills were categorized into 5 moral-social, technical-technological, educational-learning, personal-managerial, and supervisory-supportive categories. Then, with the help of the fuzzy Delphi method, these skills were examined by a panel of 20 experts, and after 4 stages, all the identified skills were approved by the expert group. Therefore, in this study, it was determined that 31 skills are considered for virtual education teachers. In the meantime, we can safely say that 12 skills of social facilitation and appropriate counseling, conflict management, professional and ethical commitment, strategies and applications of learning theories, scholarly and research skills and knowledge sharing, skills to facilitate the teaching process, lectures Online, encouraging and motivational skills, administrative and operational organizational skills, maintaining communication with students after completing the course, feedback, and monitoring learning activities, which were approved in the first round of the fuzzy Delphi method, are the most important skills of virtual education. and therefore, skills should be emphasized more in virtual courses.

Of course, due to the emerging nature of the subject and the lack of comprehensive research on the subject, especially in the post-corona period, the authors face a problem for comparison. But in general, this research can be compared with the research of other researchers such as Hajizadeh et al. [40], Narenji et al. [44], Golabi et al [52], Bashir et al. [53], Santos Karimi et al. [54], Goli et al. [55] and Mehralian and Maghami [56] who sought to identify the skills and competencies of teachers or provide a suitable model in the field of virtual education, are in line.

It is suggested that the skills identified for academic staff members for virtual education should be given more attention in universities and higher education institutions, and training courses should be held to strengthen these skills of virtual course instructors. It is also suggested that these skills should be carefully considered by the educational authorities, and with the cooperation and coordination of all the beneficiaries of virtual education, meet the needs and requirements of virtual education to strengthen these skills, and promote the development of virtual education, in the future, it will be considered as an effective supplement to traditional education and will cause the growth, improvement of capabilities and education of students as well as possible.

It is suggested to implement virtual education skill training and skill assessment courses for academic staff members. It is suggested that to promote the professors, these skills of virtual education known in this research should be somehow included in the promotion regulations.

Finally, it is suggested that in future research, the skills identified in this research should be measured in different universities and for different lecturers, and if there is a deficiency, the existing situation should be changed to a favorable situation in terms of the skills required by academic staff members. It is suggested to investigate these skills among

different universities with a comparative perspective and make an optimal comparison. It is suggested to identify the skills of virtual education instructors with other approaches of qualitative studies, such as meta-synthesis, and test and rank them using advanced quantitative methods. It is suggested that while refining and customizing this model and its variables, they should be used and compared in universities and higher education institutions. The main limitation of this research is the challenges and problems in collecting information and interviewing experts, as well as feedback to them, in the fuzzy Delphi approach, as well as the long and time-consuming process during the research.

Authors' contributions

The authors are equally involved in the preparation and presentation of the article.

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Conflict of interest

No conflicts of interest are declared by the authors.

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AUTHOR(S) BIOSKETCHES

Amir Fazel is an assistant professor in the Department of Business Management, Baft Higher Education Center, Shahid Bahonar University of Kerman. His field of interest is management and information technology. He completed his master's and doctorate studies in Human Resource Management at the University of Sistan and Baluchistan and has published 14 articles on management and information technology issues.

Fazel, A. Assistant Professor, Business Management, Baft Higher Education Center, Shahid Bahonar University of Kerman, Kerman, Iran.

amir.fazel@uk.ac.ir

Azin Harandi Ph.D. in Business management, is a researcher and university lecturer. Her field of interest is strategic management and educational management. She completed her master's degree at Allameh Tabatabai University, and a doctorate in business management at Payam Noor University of Graduate Studies and has published 13 articles on management and information technology issues.

Harandi, A Ph.D. in Business Management, Baft Higher Education Center, Shahid Bahonar University of Kerman, Kerman, Iran.

azin.harandi@gmail.com

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ORIGINAL RESEARCH PAPER

A consideration of the roles of preservice teachers' information literacy, digital literacy, and ICT self-efficacy in teaching

***A. Ramazani*[*,1], *Z. Talebi*[2].**

[1] *Department of Educational Administration, Farhangian University, Tehran, Iran*
[2] *Department of English Language Teaching, Farhangian University, Zanjan, Iran*

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* Corresponding author
a.ramezani@cfu.ac.ir
(+98912) 5411015

ABSTRACT

Background and Objectives: Today, technology has an important role to play in regulating society's lifestyle. People's lives are dominated by an information environment because of rapid technological progress in computers, the Internet, and smartphones. Information and communication technology (ICT) is a special branch of IT facilitating access to information. ICT can help to improve teachers' teaching experiences and prepare them for the demands of the 21st century. To be effective in the use of ICT, teachers are required to have adequate self-efficacy teaching skills. ICT self-efficacy is the concept of an individual's belief that he or she can use information and communication technologies for specific tasks. The skills of information literacy and digital literacy are required for teachers to develop their own ability to use ICT. With this consideration, the relationship between information literacy and digital literacy of preservice teachers and their ability to use ICT for learning purposes is investigated in this study.

Materials and Methods: In this study, a survey research design was employed as the methodology. Data were collected using online questionnaires, and the collected data were analyzed using Confirmatory Factor Analysis (CFA). To gather data for this study, an online survey comprising two questionnaires was administered to students enrolled in teacher training programs at Farhangian University in Zanjan, Iran in 2023. One of the frameworks used as a questionnaire was rigorously developed and validated by Pinto and Markauskaite et al., while the other one was taken from the Global Framework of Reference on Digital Literacy Skills. Participants were chosen from study groups which were selected through stratified cluster sampling. Out of 1700 preservice teachers in two branches of Farhangian University (Alzahra and Shahid Beheshti), 313 preservice teachers were selected as the representatives (which was calculated based on the Morgan Table). To investigate the correlation between latent variables, survey data have been analyzed using CFA. For the evaluation of the proposed framework, structural equation modeling (SEM) was also used.

Findings: The outcomes of the CFA and SEM analysis revealed that how pre-service teachers perceive their information literacy directly and positively affects their perception of digital literacy. Additionally, the results showed that pre-service teachers' perceived information literacy has a direct and positive influence on their self-confidence in using ICT for teaching, also known as ICT self-efficacy. Furthermore, the research findings indicated that the way pre-service teachers perceive their digital literacy directly and positively impacts their self-confidence in utilizing ICT for teaching. However, when compared to perceived digital literacy, the perceived information literacy of preservice teachers has a more pronounced effect on their ICT self-efficacy in the context of teaching.

Conclusions: The research findings emphasize the importance of giving priority to the development of information literacy and digital literacy skills for pre-service teachers in the field of education. This is because these skills are strongly correlated with higher levels of ICT self-efficacy. The study also underscores the necessity for teacher training and professional development programs that specifically target the enhancement of information literacy and digital literacy. By focusing on these literacies, such programs have the potential to improve preservice teachers' ICT self-efficacy in teaching and enhance the effective utilization of ICT in educational settings.

NUMBER OF REFERENCES	NUMBER OF FIGURES	NUMBER OF TABLES
56	1	10

مقاله پژوهشی

بررسی نقش سواد اطلاعاتی، سواد دیجیتال و خودکارآمدی ICT دانشجومعلمان در تدریس

عباس رمضانی*[1]، زهرا طالبی[2]

[1] گروه مدیریت آموزشی، دانشگاه فرهنگیان، تهران، ایران
[2] گروه آموزش زبان انگلیسی، دانشگاه فرهنگیان، زنجان، ایران

چکیده

پیشینه و اهداف: در قرن بیست و یکم، فناوری نقش مهمی در تنظیم سبک زندگی جامعه دارد. به‌دلیل پیشرفت سریع فناوری در رایانه، اینترنت و تلفن های هوشمند، زندگی مردم تحت سلطه یک محیط اطلاعاتی است. فناوری اطلاعات و ارتباطات شاخه خاصی از فناوری اطلاعات است که دسترسی به اطلاعات را تسهیل می کند. فناوری اطلاعات و ارتباطات می تواند به بهبود تجارب تدریس معلمان و آماده سازی آن ها برای خواسته های قرن ۲۱ کمک کند. به منظور اثربخشی در استفاده از فناوری اطلاعات و ارتباطات، معلمان ملزم به داشتن مهارت های آموزشی خودکارآمدی کافی هستند. خودکارآمدی فناوری اطلاعات و ارتباطات مفهومی است که فرد باور دارد که توانایی استفاده از فناوری اطلاعات و ارتباطات را برای وظایف خاص دارد. مهارت‌های سواد اطلاعاتی و سواد دیجیتالی برای اینکه معلمان توانایی خود را در استفاده از فناوری اطلاعات و ارتباطات توسعه دهند، مورد نیاز است. با این ملاحظات، در این پژوهش رابطه بین سواد اطلاعاتی و سواد دیجیتالی معلمان پیش از خدمت و توانایی آنها در استفاده از فناوری اطلاعات و ارتباطات برای اهداف یادگیری بررسی شده است.

روش‌ها: این پژوهش از طرح تحقیق پیمایشی، جمع‌آوری داده‌ها از طریق پرسشنامه آنلاین و تحلیل داده‌ها از طریق تحلیل عاملی تأییدی بهره برده است. برای جمع‌آوری داده‌ها، یک نظرسنجی آنلاین مشتمل بر دو پرسشنامه، در بین دانشجومعلمان دانشگاه فرهنگیان زنجان در سال ۱۴۰۲ انجام شد. یکی از پرسشنامه‌ها توسط پینتو و مارکاوسکایت تدوین گردیده و روایی و پایایی آن تایید شد، در حالی که پرسشنامه دوم از چارچوب مرجع جهانی مهارت های سواد دیجیتال گرفته شده است. شرکت کنندگان از میان گروه های مورد مطالعه با شیوه نمونه‌گیری خوشه‌ای طبقه‌ای گزیده شدند و از مجموع ۱۷۰۰ دانشجومعلم در دو پردیس دانشگاه فرهنگیان زنجان (الزهرا و شهید بهشتی)، ۳۱۳ دانشجومعلم به عنوان نمونه انتخاب شدند که طبق جدول مورگان کفایت لازم برای نمایندگی جامعه مذکور را دارد. داده های نظرسنجی با استفاده از تحلیل عاملی تاییدی (CFA) برای بررسی رابطه بین متغیرهای نهفته تجزیه و تحلیل شد. برای ارزیابی چارچوب پیشنهادی از مدل سازی معادلات ساختاری (SEM) نیز استفاده شده است.

یافته‌ها: نتایج تحلیل CFA و SEM نشان داد که ادراک دانشجومعلمان از سواد اطلاعاتی، تأثیر مستقیم و مثبتی بر درک آنها از سواد دیجیتال دارد. همچنین یافته ها نشان داد که سواد اطلاعاتی دانشجومعلمان تأثیر مستقیم و مثبتی بر اعتماد به نفس آن ها در استفاده از فناوری اطلاعات و ارتباطات برای تدریس دارد (خودکارآمدی). علاوه بر این، این مطالعه نشان داد که سواد دیجیتال ادراک شده دانشجومعلمان نیز تأثیر مستقیم و مثبتی بر اعتماد به نفس آن ها در بهره‌گیری از فناوری اطلاعات و ارتباطات برای تدریس دارد. با این حال، در مقایسه با سواد دیجیتال ادراک شده، سواد اطلاعاتی ادراک شده تأثیر قوی تری بر خودکارآمدی ICT دانشجومعلمان در هنگام تدریس دارد.

نتیجه‌گیری: نتایج این مطالعه اهمیت اولویت‌دهی دانشجومعلمان به توسعه مهارت‌های سواد اطلاعاتی و همچنین مهارت‌های سواد دیجیتال را نشان می‌دهد، زیرا ارتباط تنگاتنگی با خودکارآمدی بالاتر در فناوری اطلاعات و ارتباطات در میان دانشجو معلمان در حین تدریس دارند. . همچنین نیاز به آموزش معلمان و برنامه‌های توسعه حرفه‌ای با تمرکز بر افزایش سواد اطلاعاتی و سواد دیجیتال را متذکر می‌گردد؛ زیرا این سوادها پتانسیل بهبود خودکارآمدی ICT دانشجومعلمان را در تدریس و استفاده بیشتر از فناوری اطلاعات و ارتباطات در محیط‌های آموزشی دارند.

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*نویسنده مسئول
a.ramezani@cfu.ac.ir
۰۹۱۲-۵۴۱۱۰۱۵

Introduction

There has been a significant increase in the advancement of information and communication technology (ICT), which has had a profound impact on various fields, including education [1]. In the educational context, teachers play a crucial role in implementing and integrating ICT into their teaching practices, as they possess expertise in delivering educational content [1-2]. The effective integration of ICT in education heavily relies on the preparation of

individual teachers to utilize technological tools [3]. The self-efficacy of teachers in using ICT forms the foundation for their comfort and confidence in utilizing technology in the classroom.

It is suggested that an individual's feelings and beliefs about their own thoughts and actions are the basis for self-efficacy. These beliefs on self-efficacy also play a major role in the development of an individual's mind, emotions, and motivation. Teachers 'efficacy is based on their belief and trust that they can teach effectively in the classroom [5]. Individuals' self-efficacy is influenced by specific activities. With regard to teachers' teaching practices with ICT, Krumsvik [6] underlines the importance of taking into account their ability to act independently. Hatlevik and Hatlevik [7] distinguish between general ICT self-efficacy and ICT self-efficacy for educational purposes. ICT self-efficacy is strongly linked to teacher motivation in carrying out the mission of education [8], their level of job satisfaction [9], the creation of innovative learning designs, and the active involvement of students [10]. Furthermore, it plays a role in enhancing overall well-being [11-10].

Related to the concept of ICT, digital literacy has emerged as a significant issue for those within the education sector, encompassing students, educators, and policymakers. Therefore, to enhance the effectiveness of education in this digital age and aid in achieving set objectives, English teachers should possess advanced digital skills. In addition, the concept of digital literacy is inextricably related to a further significant field: Information Literacy which requires individuals to access and use current information.

In general, there has been a lack of research on teacher ICT self-efficacy with regard to information and digital literacy. The dearth of research in this area certainly gives rise to sufficient grounds for an investigation into the relationship of Iranian EFL teachers with respect to their level of ICT self-efficacy and Digital and Information Literacy. This paper therefore aims to provide novel insight into this area by studying the relationship between perception of information and digital literacy, as well as teachers' perceptions of ICT self-efficacy for teaching goals. The primary aim of the research is to investigate the impact of perceived information and digital literacy on preservice teachers ICT self efficacy in teaching context. For this purpose, the following research questions have been proposed:

- Does information literacy have an impact on the ability of preservice teachers to use ICT effectively?
- Does digital literacy have an impact on the ability of on the ability of preservice teachers to use ICT effectively?
- How does preservice teachers' information literacy relate to their digital literacy?

Review of the Related Literature

Information literacy

At first, research into information literacy primarily took place in the field of library studies. However, there has been a growing emphasis on education research in both higher education and school settings [12-16]. Individuals with information literacy have been defined as those who can obtain and evaluate information to meet their information needs [17]. Changes in the curriculum of Higher Education and Teacher Training are required by the evolution of information resources [18]-[19]. In 2000, the Association of Colleges and Research Libraries announced that information literacy includes a set of skills whereby individuals can recognize their need for information, learn how to find it, assess its value, and use it efficiently. In a 'new curriculum

for information literacy' [20], student learning in the digital era depends on their possession of information literacy as a collection of skills, attributes, and behaviors. La [21] included library skills and computer literacy as essential components of Information Literacy.

The lack of information literacy skills could lead to difficulties in adapting to the ever-changing world of information technology. Shannon et al. [22] claimed that teachers are often deficient in information literacy skills and highlighted examples where they were not well acquainted with the concept of information literacy or did not understand it within their teaching curriculum. Furthermore, they noticed that information literacy courses are not being taught in all teacher training programs. These results are in line with previous studies, which showed that students have not developed the necessary information literacy skills [23].

A set of digital skills that include operational, formal, information, communications, content creation, and strategic skills have been presented by Van Dijk and Van Deursen [24]. They point out the absence of a focus on information literacy skills. Information literacy includes a variety of skills and competencies [25], e.g., the ability to consider the quality and relevance of information relating to search targets, evaluating the reliability and value of information as well as taking advantage of new information for professional practice and planning purposes.

Information Literacy is a fusion between library literacy, computer and media literacy, as well as digital literacy [26]. Acquiring these literacies empowers information users to become self-reliant lifelong learners. Information literacy enables people to distinguish between information needed and the particular kinds of information they need. It provides information resource users with strategies to navigate the vast amount of information available from different sources.

While in the past, it has been thought that people could access information without ICT literacy, today's IT-driven society is intimately linked to Information Literacy [27]. Teachers need to be able to effectively search and find information through digital means in the 21st-century knowledge age so that they can pass it on to future generations. It is not known what level of information literacy the teachers possess and whether they are willing to take part in an information search. Lack of confidence and ability to search for information in their profession, which has always been a concern, was reported by Best et al. [28]. Consequently, it is possible to assume that preservice teachers need information literacy skills for effective use of information resources and ICT.

ICT self-efficacy in teaching

According to Bandura's social cognitive theory of behavior change, self-efficacy is defined as "individuals' beliefs in their ability to achieve desired levels of performance and exert influence over events that impact their lives" [4, p. 82]. In many instances, self-efficacy may be specific to one context or domain and Bandura's theory suggests that it is in many cases more appropriate to look at the individual domains of self-efficacy.

The self-efficacy of teachers is about their personal belief that they are capable of planning and achieving educational objectives [29]. The level of self-efficacy among teachers determines their belief in their ability to influence student learning and behavior. It should be noted that self-efficacy is not about the different skills a teacher has, but rather his or her belief as to what he or she will achieve with these skills in an individual situation [4] and how they can successfully perform their

tasks [30]. Research has demonstrated that teachers' belief in their own capabilities, referred to as self-efficacy, has multiple positive effects. Firstly, it enhances their motivation [8]. Secondly, it facilitates the development of innovative instructional design [29]. Lastly, it fosters a positive and responsive classroom environment [31]. Due to these benefits, self-efficacy is considered crucial for teachers' actual teaching practice [3].

A correlation of self-efficacy with education outcomes was underlined by several research findings [10], and Recent studies that showed that a teacher's self-efficacy and educational quality are related have contributed to this area of research [32]. The positive correlation between teachers' self-efficacy to use technology and integrating ICT into their teaching practices has been observed [3]. Nonetheless, the frequency of ICT usage is a crucial factor, as infrequent use of ICT is linked to lower levels of ICT self-efficacy [33].

Teachers' self-efficacy is also important in determining the effort level they invest in areas such as information and digital literacy, as well as their resilience when faced with challenges and difficulties in utilizing or adjusting ICT for teaching goals. Therefore, teachers' success in incorporating ICT into their teaching is influenced by various factors, with information literacy and digital literacy being particularly significant [29]. While teacher training in ICT can positively impact the use of computers by teachers, improving their own self-efficacy, it is worth noting that there may not always be a direct correlation between proficiency in ICT and higher self-efficacy [34].

Digital Literacy

To mitigate the significant impact of technological advancements on teachers' careers, teachers need to possess and continuously improve their competencies. While accessing and using digital platforms appear intuitive, effective utilization requires digital literacy [35]. Digitally literate individuals inevitably develop technology skills. For individuals, digital literacy training gives them the ability to use computers, software applications, databases and more technology in pursuit of their individual, professional, or educational goals.

The emergence of new developments and technologies has brought about changes in communication, learning, information creation, work, and governance for individuals, groups, and societies [36]. It is also essential that individuals have not only the capacity and skills to use technology tools but also knowledge of adequate standards and practices within this new societal reality [37]. Understanding when information is required, where to find it, and how to use it effectively are crucial for digital literacy in the 21st century [38]. Teachers must be equipped with knowledge that can effectively satisfy the technological and informational needs of a generation that will shape information society in the 21st century [39]. Integration of technology is crucial for teachers to cope with rapid technological developments that affect teaching environments [40].

It is argued that digital literacy skills, including various technical skills, are also acquired by individuals with information literacy skills [41]. Digital literacy encompasses information literacy skills such as locating and utilizing necessary information, as well as communication, collaboration, digital social awareness, e-security awareness, and information creation [42]. Today's digital environment provides teachers with an exclusive opportunity to access information, tools, and resources for teaching and learning. Teachers must therefore possess the

knowledge and skills in information and digital literacy. In the 21st century, it has become an essential skill and a requirement to gather information using digital tools and to present it in a way that supports students' learning at their own level, while also becoming content creators with the necessary digital skills. It is necessary to have information and digital literacy skills for teachers who play an important role in shaping future generations. Accordingly, the following hypotheses are postulated:

(H1) The digital literacy of the preservice teachers is directly affected by perceived information literacy.

(H2) Preservice teachers' ICT self-efficacy in teaching is directly affected by perceived information literacy.

(H3) Preservice teachers' ICT self-efficacy in teaching is directly affected by perceived digital literacy.

Method

Participants

The participants in this study were pre-service teachers from Farhangian University in Zanjan Province, Iran. A student who enrolled in a teacher training program is considered to be the pre-service teacher. Farhangian University is a public institution dedicated to teacher training, consisting of over 90 teacher-training colleges and enrolling more than 39,000 students. It plays a significant role in preparing pre-service teachers across various disciplines in Iran.

A total of 310 students took part in the research, with 200 students (64.5%) from Alzahra University and 110 students (35.5%) from Shahid Beheshti University. Both universities offer undergraduate programs for individuals aspiring to become preschool and elementary school teachers, subject teachers, and special educators across all grade levels. Additionally, the universities provide professional development and improvement courses for practicing teachers.

The stratified cluster sampling method was used to guarantee the representativeness of the study sample. This method divided the primary sample of two Farhangian universities into study groups and assigned different majors a list of all university study groups. A random sample of study groups was selected from each major, and all students in each selected study group participated in the study. The 5% confidence interval and 95% confidence level have been used for calculating the reliability of the sample.

According to the Farhangian University of Zanjan, there were 1701 students enrolled in teacher training programs in 2022 in Zanjan, Iran. The researchers were able to determine the relevant sample size of their study using a Krejcie and Morgan table, without having to examine every single person in the population. Based on the Krejcie and Morgan Table, if the population consists of 1700 people, the table can be referenced to determine that the researcher only needs feedback from 313 individuals. This facilitates the conduct of a quantitative study for the research. The selected sample of 310 students was therefore considered to be representative.

Instruments

Online questionnaires were prepared and made accessible for participants to complete. From September to October 2022, students were invited to the study, which was conducted using an online survey. Participation was voluntary because of the online implementation of the survey.

In this study, a survey was carried out to assess the level of ICT self-efficacy in teaching, as well as the perception of information literacy and digital literacy of preservice teachers. The

survey consisted of two questionnaires, one of which had been rigorously created by Markauskaite et al. [43] and Pinto [11] respectively, and the other was taken from the Global Framework of Reference on Digital Literacy Skills [44].

Markaiteuska and al. [43] have developed an ICT literacy assessment section for measuring the self-efficacy of preservice teachers in using information and communication technologies to teach. The intention to use ICT in future work is addressed in this section, which includes six components related to the belief in the use of ICT in teaching careers. In this study, only one element, the perception that ICT is used for enhancing education and learning has been analyzed. This component was used to create a latent variable (ICT-S), which is represented by seven observed variables. The latent factor is identified as the unobserved variable, ICT-S.

Pinto's certified tool for IT literacy, the simple version of information literacy and humanities and social science (IL-HUMASS) which is available online was also used. The use of this instrument was to explore the opinion of preservice teachers about the phenomenon of information literacy. In addition, the Global Framework of Reference on Digital Literacy Skills [44] was used to analyze perceived digital literacy (DL) (Table 2). The measured latent factor (IL) consists of eight observed variables, while the measured latent factor (DL) consists of five observed variables (Table 2).

The convergent validity of three latent variables was assessed: ICT-S, IL, and DL. For the ICT-S variable, we used the average variance extracted (AVE) and composite reliability (CR) measures, which showed that AVE = 0.614 (> 0.50) and CR = 0.899 (> 0.70), indicating appropriate convergent validity and composite reliability. Similarly, for the IL variable, the AVE and CR values were AVE = 0.605 (> 0.50) and CR = 0.912 (> 0.70), respectively, suggesting satisfactory convergent validity [45].

Therefore, the convergent validity and composite reliability are deemed suitable. Lastly, we evaluated the convergent validity of the latent variable IL-E using the AVE and CR measures, which yielded AVE = 0.693 (> 0.50) and CR = 0.749 (> 0.70). This indicates that the convergent validity and composite reliability of IL are also appropriate.

To assess the internal consistency of the latent variable ICT-S, Cronbach's alpha was employed. The findings affirmed that the items within the variable are strongly interrelated as a collective. Specifically, the Cronbach's alpha value for ICT-S was 0.883 (> 0.65), indicating high internal consistency. Additionally, the normality of the ICT-S dataset was examined by analyzing the skewness and excess kurtosis. The absolute values of both skewness and kurtosis, which should be less than 2 for normality, were evaluated (Table 3).

To assess the internal consistency of the latent variable IL, we employed Cronbach's alpha. The findings indicated a strong interrelationship among the IL items as a whole. Specifically, the Cronbach's alpha value for IL was 0.877 (> 0.65), suggesting high internal consistency. Additionally, we examined whether the IL dataset followed a normal distribution. The absolute values of skewness and kurtosis were evaluated, and they indicated the normality of the IL dataset (absolute values were less than 2; Table 4).

The fitness of the latent variable (DL) items revealed sufficient fit and confirmed six questionnaire blocks. The internal reliability of this question group was confirmed by Cronbach’s alpha values of 0,877 to 0.650. Then, the normality of the (DL) data was checked. The absolute values for skewness and kurtosis indicate the normality of the (DL) data set (absolute values are less than 2; Table 5).

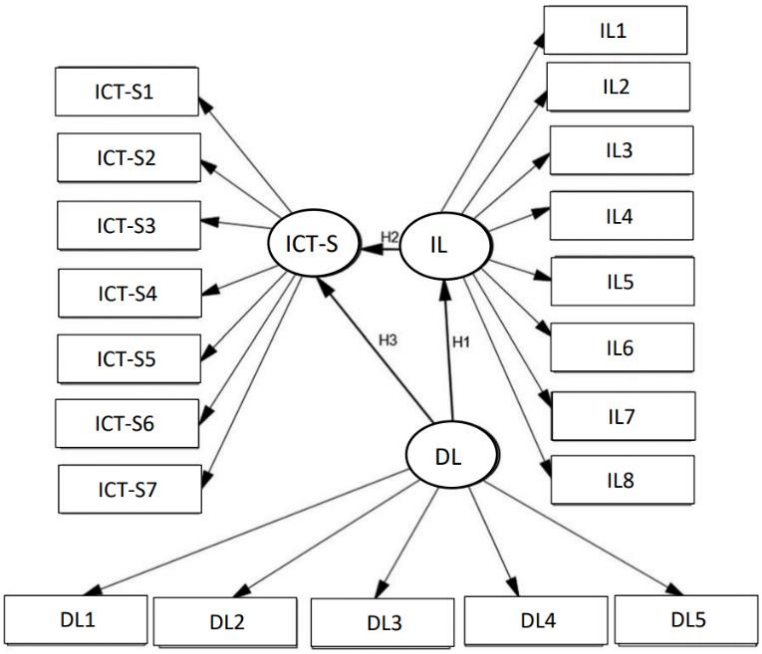

Fig. 1: The conceptual model of the relationship between variables: ICT-S, IL, and DL

Table 1: The internal content of the variable latent: ICT self-efficacy in teaching, (ICT-S)

Code	Items: I think I will
ICT-S_1	Find ways to enhance classroom teaching by incorporating ICT activities
ICT-S_2	Integrate ICT into my standard classroom curriculum
ICT-S_3	Use various methods of delivering new information
ICT-S_4	Create assignments that require students to submit work that has been created using ICT
ICT-S_5	Develop assignments that require students to utilize ICT tools for presentations
ICT-S_6	My students will utilize different software tools for mind mapping and brainstorming
ICT-S_7	Develop lesson plans that focus on teaching students ICT skills within specific subjects

Table 2: Latent variables in the perception of information literacy: information literacy (IL) and digital literacy (DL)

The latent variable	Observed variable codes	The observed variable
Information literacy (IL)	IL_1	To use physical sources of information including books and papers for this purpose
	IL_2	To access and use automated catalogs
	IL_3	To refer to and utilize the main information sources electronically
	IL_4	To utilize secondary sources of information through electronic means
	IL_5	To familiarize oneself with terms that apply to the subject
	IL_6	To search the Internet to find and access information
	IL_7	To use informally accessible digital sources of information
	IL_8	To understand tactics for searching for information
Digital literacy (DL)	DL_1	To know what digital content is necessary for the operation of software technologies
	DL_2	To assess, compare, and critically evaluate the credibility and reliability of digital content sources
	DL_3	To explore and locate data, information, and content within digital environments
	DL_4	To share data, information, and digital content with others
	DL_5	To utilize digital tools and technologies to facilitate cooperation

Table 3: ICT-S data set normality: pre-service teachers' self-efficacy in enhancing teaching and learning with ICT

	ICT-S1	ICT-S2	ICT-S3	ICT-S4	ICT-S5	ICT-S6	ICT-S7
Skewness	-1.026	-1.228	-1.760	-0.918	-0.858	-1.037	-1.037
S.E	0.153	0.153	0.153	0.153	0.153	0.153	0.153
Kurtosis	0.859	1.978	1.884	0.595	0.487	1.160	1.254
S.E	0.305	0.305	0.305	0.305	0.305	0.305	0.305

Table 4: Normality of (IL) model data: pre-service teachers' perceived information literacy

	IL1	IL2	IL3	IL4	IL5	IL6	IL7	IL8
Skewness	-1.910	-0.895	-1.230	-1.038	-0.610	-1.012	-0.716	0.050
S.E	0.153	0.153	0.153	0.153	0.153	0.153	0.153	0.153
Kurtosis	1.315	0.311	1.231	0.689	0.560	0.464	-0.415	-0.421
S.E	0.305	0.305	0.305	0.305	0.305	0.305	0.305	0.305

Table 5: Pre-service teachers perceived digital literacy (DL): normality of data

	DL1	DL2	DL3	DL4	DL5
Skewness	-0.609	-0.970	-0.609	-0.799	-0.598
S.E	0.153	0.153	0.153	0.153	0.153
Kurtosis	0.326	2.047	0.105	0.595	0.599
S.E	0.305	0.305	0.305	0.305	0.305

Results and Findings

To examine two hypotheses (H1 and H2), we utilized the robust SEM software Amos for structural equation modeling (SEM). This approach allowed us to explore the relationships among the latent variables (ICT-ST, IL, and DL). SEM consists of two components: a measurement model, which is essentially CFA, and a structural model.

A CFA was conducted to examine the internal structure of the latent variables: pre-service teachers' self-confidence in teaching (ICT-S), perceived information literacy (IL), and perceived digital literacy (DL).

A CFA was conducted to examine the ICT self-efficacy in teaching (ICT-S) latent variable. Unstandardized coefficients (β) for both the observed variables and the latent factor (ICT-S) were calculated and are presented in Table 7. The unstandardized beta value indicates the impact of the predictor (observed) variable on the dependent (latent) variable.

The standardized beta (β) is comparable to a correlation coefficient. The self-efficacy of pre-service teachers in teaching with ICT is most strongly associated with 'Develop assignments that require students to utilize ICT tools for presentations '(β = 0.765; Table 7). The results of the CFA indicate that the relationship between the predictor (observed) variables and the dependent (latent) variable (ICT-S) was statistically significant for all cases (Table 7).

The CFA results provide the coefficient of determination (R2) for each aspect, indicating the percentage of variation in the ICT-S model explained by the observed variables. The coefficient of determination (R2) for the variable teachers' ICT-S ranged from 42.7% to 58.4% (Table 4). This implies that 42.7% to 58.4% of the data align with the regression model.

A CFA was performed on the latent variable 'perceived information literacy' (IL) (Tables 8, 9). The CFA results indicated a statistically significant relationship between the latent variable (IL) and all variables of perceived information literacy (Table 8). The highest unstandardized beta values were observed for information strategies (B = 1.729) and searching for and retrieving internet information (B = 1.612), while the lowest value was for utilizing electronic sources of primary information (B = 0.843; Table 8). The coefficient of determination (R2) suggests that the data closely align with the regression lines, as the absolute values of R2 exceed 0.20 (Table 8).

A CFA of the respondents' perceived digital literacy according to the Global Framework of Reference on Digital Literacy Skills was performed. Standardized and unstandardized coefficients for the observed variables and the latent variable (DL) were deducted (Table 9).

The results of the CFA showed that pre-service teachers' belief in their ability to search for data in digital environments was strongly linked to their perceived digital literacy. The coefficient of determination for the latent variable (IL) was high, indicating that pre-service teachers were skilled in analyzing, comparing, and evaluating the credibility and reliability of digital sources, as well as exploring data, information, and content in digital environments.

The results of CFA revealed that the relation of the predictor (observed) variables to the dependent (latent) variable (IL) was statistically significant in all cases (Table 9).

As mentioned earlier, SEM, in comparison with CFA, extends the possibility of relationships among the latent variables. We analyzed the relationship between perceived information literacy and perceived digital literacy (H_1), the relationship between perceived information literacy and ICT self-efficacy in teaching (H_2), and the relationship between perceived digital literacy and ICT self-efficacy in teaching (H_3).

The findings of SEM (*p* values) revealed that pre-service teachers' perceived information literacy directly and positively affects perceived digital literacy ($B = 0.988$), ($R^2 = 0.543$, $p < 0.01$). The findings showed that perceived information literacy directly and positively affects the ICT self-efficacy in the teaching of pre-service teachers ($B = 0.555$), ($R^2 = 0.660$, $p < 0.01$). It also revealed that perceived digital literacy directly and positively affects ICT self-efficacy in teaching ($B = 0.357$), ($R^2 = 0.660$, $p < 0.01$).

The greatest R^2 values involve H2 and H_3 (Table 10). This means that 66.2% of preservice teachers' ICT self-efficacy in teaching is influenced by perceived information and digital literacy. The remaining 33.8% is influenced by other factors.

Table 6: Fitness of items for the latent variables: Model ICT-S, IL, DL, and final model

Model		Absolute fit index		Relative fit index			
		χ^2/df	RMSEA	GFI	IFI	TLI	CFI
ICT-S	Assumed model	2.015	0.059	0.970	0.996	0.968	0.997
IL	Assumed model	2.101	0.065	0.987	0.981	0.960	0.992
DL	Assumed model	1.281	0.043	0.992	0.999	0.989	0.999
Structural model	Assumed model	2.305	0.074	0.875	0.941	0.927	0.935
	Acceptance value	1–5	< 0.08	> 0.80	> 0.90	> 0.90	> 0.90

Table 7: Standardized and unstandardized coefficients for the latent variables of ICT self-efficacy in teaching

Code of observed variable	Observed variable	*R2*	*B*	*S.E*	β	*p*
ICT-S_1	Find ways to enhance classroom teaching by incorporating ICT activities	0.525	0.841	0.076	0.728	<.001
ICT-S_2	Integrate ICT into my standard classroom curriculum	0.522	0.765	0.072	0.725	<.001
ICT-S_3	Use various methods of delivering new information	0.425	0.674	0.066	0.655	<.001
ICT-S_4	Create assignments that require students to submit work that has been created using ICT	0.501	0.951	0.086	0.716	<.001
ICT-S_5	Develop assignments that require students to utilize ICT tools for presentations	0.574	1.052	0.092	0.763	<.001
ICT-S_6	My students will utilize different software tools for mind mapping and brainstorming	0.499	0.881	0.083	0.695	<.001
ICT-S_7	Develop lesson plans that focus on teaching students ICT skills within specific subjects	0.569	1.010		0.759	

Table 8: **Standardized and unstandardized coefficients for the latent variables of pre-service teachers' perceived information literacy (IL)**

Code of observed variable	Observed variable	*R2*	*B*	*S.E*	β	*p*
IL_1	To use physical sources of information including books and papers for this purpose	0.280	1.002		0.525	<.001
IL_2	To access and use automated catalogs	0.295	0.937	0.089	0.534	<.001
IL_3	To refer to and utilize the main information sources electronically	0.250	0.843	0.121	0.512	<.001
IL_4	To utilize secondary sources of information through electronic means	0.542	1.586	0.221	0.753	<.001
IL_5	To familiarize oneself with terms that apply to the subject	0.563	1.569	0.213	0.789	<.001
IL_6	To search the Internet to find and access information	0.616	1.612	0.213	0.789	<.001
IL_7	To use informally accessible digital sources of information	0.357	1.261	0.188	0.597	<.001
IL_8	To understand tactics for searching for information	0.563	1.729	0.237	0.763	<.001

Table 9: Standardized and unstandardized coefficients for the latent variables of pre-service teachers' perceived digital literacy (DL)

Code of observed variable	Observed variable	*R2*	*B*	*S.E*	β	*p*
DL1	To know what digital content is necessary for the operation of software technologies	0.274	0.791	0.118	0.531	<.001
DL2	To assess, compare, and critically evaluate the credibility and reliability of digital content sources	0.730	1.446	0.194	0.849	<.001
DL3	To explore and locate data, information, and content within digital environments	0.772	1.460	0.197	0.881	<.001
DL4	To share data, information, and digital content with others	0.115	0.812	0.160	0.315	<.001
DL5	To utilize digital tools and technologies to facilitate cooperation	0.243	1.001		0.485	

Table 10: Standardized and unstandardized coefficients of structural model: ICT self-efficacy in teaching; information literacy; digital literacy

Hypothesis	Path analysis	Effect	R^2	B	S.E	β	*p*
H_1 confirmed	DL→IL	Direct	0.543	0.988	0.111	0.741	<.001
H_2 confirmed	IL→ICT-S	Direct	0.660	0.555	0.098	0.579	<.001
H3 confirmed	DL→ICT-S	Direct	0.660	0.357	0.121	0.291	<.001

Discussion

The research examined the impact of perceived information and digital literacy on the preservice teacher's self-efficacy in the use of ICT for teaching. The results of the hypotheses in the research align with findings from other authors. General ICT self-efficacy has been found to predict strategies for the evaluation of information literacy [3].

Several studies have explored the concept of information literacy and self-efficacy, with Yan et al. [46] emphasizing its importance in dealing with information overload. In a world with an abundance of information, information literacy helps us determine what information is necessary, when and where to find it, and how to effectively utilize it [47]. In their analysis of the connection between self-efficacy and information literacy among online learners, Tang and Tseng [48] found that self-efficacy for information searching is positively associated with self-efficacy for online learning. Additionally, the positive association between self-efficacy in online education and information manipulation can be seen.

The findings of this study are also consistent with those of Pınar Kahveci [49], who found a strong positive correlation between digital literacy and teachers' self-efficacy. Another study by Maria Ulfatul Jamila et al. [50] suggested that digital literacy affects behavioral intention with ICT self-efficacy. Overall, the results suggest that ICT self-efficacy is positively affected by digital literacy enabling technology to be used more effectively in a variety of contexts.

Several studies have also established a positive correlation between information literacy and digital literacy. One of the findings in a study conducted by Seda Guduzalp [51], is that teachers' knowledge of information literacy impacts positively on their digital literacy skills. In another study by Rosanne Marie Cordell [52], information literacy and digital literacy are not considered opposing concepts; instead, they are interconnected and crucial for students pursuing higher education. Digital literacy, which involves understanding and using information in various formats from numerous sources, especially those presented via computers, provides the fundamental skills required for managing digital environments.

The findings from hypothesis testing align with the results of previous researchers [7]-[9]-[6]-[53] who have indicated that the ICT self-efficacy of teachers plays a crucial role in their ability to incorporate ICT into their teaching practice. These studies have also found that higher levels of ICT self-efficacy are correlated with greater confidence in using ICT for teaching purposes. Additionally, Hammond et al. [33] discovered that teachers with lower ICT self-efficacy tend to use ICT less frequently.

The theoretical innovation of this study lies in its comprehensive examination of the research subject and the identification of clear connections between information and digital literacy and ICT self-efficacy.

Conclusions

The study's SEM results have provided updated insights into the relationships between digital literacy and ICT self-efficacy, as well as the relationships between information-searching literacy and ICT self-efficacy among preservice teachers.

The SEM findings (Table 10) highlight the practical implications for the design of information literacy programs for preservice teachers, both in terms of instructional organization and teaching principles. When creating curricula for information literacy, it is crucial to allocate sufficient time for program implementation. Based on the SEM results, it is recommended to prioritize the development of information literacy over digital literacy for preservice teachers, as information literacy has a stronger direct impact on their ICT self-efficacy (Table 10). Therefore, an integrated approach should be adopted when designing the content of information literacy and digital literacy programs for preservice teachers, encompassing both theoretical instruction and practical tasks.

Program developers should take into account the ever-evolving nature of ICT used in educational practice [1]-[2]. Insufficient knowledge about new ICT can diminish teachers' ICT self-efficacy [54]. However, as mentioned earlier, the adoption of new ICT in educational practice relies on teachers' ICT self-efficacy [7]-[9]-[6]-[53]. The SEM results demonstrate that information and digital literacy play a crucial role in determining teachers' ICT self-efficacy (Table 10). Therefore, both preservice and in-service teacher training programs should prioritize the development of information and digital literacy to enhance teachers' ICT self-efficacy, as it is closely linked to ICT integration in schools.

Authors' Contribution

A. Ramazani has made contributions to the theoretical background and the drafting and revising of the introduction, methodology, and discussion sections. Z. Talebi has contributed to collecting, analyzing, and interpreting the results. The final version of the paper was examined and endorsed by all authors.

Conflicts of Interest

The authors have no conflicts of interest.

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AUTHOR(S) BIOSKETCHES

Abbas Ramazani is an Assistant Professor in the Department of Educational Administration at Farhangian University. He holds a specialized Ph.D. in Educational Management from Shahid Beheshti University in Tehran. As a researcher, he collaborates with various executive bodies and has supervised over 40 master's and doctoral theses. He has presented approximately 40 scientific articles in journals and scientific conferences and has been actively involved in the scientific committee and review of several scientific journals and conferences. His areas of expertise include educational management, higher education, educational technology, literacy, and comparative education.

Ramazani, A. Assistant Professor, Department of Educational Administration, Farhangian University, Tehran, Iran

a.ramezani@cfu.ac.ir

Zahra Talebi is an English Teaching student in the Department of English at Farhangian University. Her areas of interest include instructional technology, EFL, and ESL issues.

Talebi, Z. English Language Teaching Student, Department of English Language Teaching, Farhangian University, Zanjan, Iran

zahtalebi7302@gmail.com

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