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ORIGINAL RESEARCH PAPER

Investigating the Mediating Role of Teachers' Digital Literacy in the Relationship Between E-Learning and Instructional Interactions in Elementary Schools in Tehran

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ABSTRACT

Background and Objectives: The rapid advancements in information and communication technologies (ICT), along with their integration into mobile devices, have transformed the landscape of education, introducing innovative methods for teaching and learning. This technological integration has significantly influenced how the learning process is conceptualized and guided. Teachers, as the primary facilitators of learning, play a pivotal role in engaging students in virtual learning environments. However, the effectiveness of e-learning in fostering teacher-student interactions is contingent upon several factors, one of the most critical being teachers' digital literacy. Digital literacy not only determines teachers' ability to utilize e-learning tools effectively but also enhances their capacity to foster meaningful instructional interactions. The aim of this study was to investigate the mediating role of teachers' digital literacy in the relationship between e-learning and instructional interactions in elementary schools in Tehran.

Materials and Methods: The research was applied in nature, with a survey-based approach adopted for data collection. The statistical population consisted of 20,968 elementary school teachers across all 19 educational districts in Tehran. Of this total, 18,824 were female and 2,144 were male. Based on Morgan's table, the sample size was estimated at 376. A multi-stage cluster sampling method was employed. Initially, Tehran was divided into five geographical regions (north, south, center, east, and west). After dividing Tehran into these geographical regions, one cluster (region) was randomly selected from each region by assigning a code. In the subsequent stage, 20 clusters (schools) were randomly selected from each chosen region by assigning codes to ensure balance among the regions. To measure the variables under study, three validated instruments were employed: the Digital Literacy Questionnaire, E-Learning Questionnaire, and Teacher-Student Interaction Questionnaire. These tools provided a comprehensive framework for assessing teachers' digital literacy, the efficacy of e-learning, and the quality of teacher-student interactions. Structural equation model and linear regression were used to analyze the hypotheses.

Findings: The findings of the study underscore the significant positive impact of e-learning on teacher-student interactions. Furthermore, digital literacy was identified as a critical mediating factor that enhances this relationship. Specifically, the results demonstrated that teachers with higher levels of digital literacy were better equipped to leverage e-learning platforms, leading to more effective instructional interactions. The mediating role of digital literacy highlights its importance as a foundational skill that amplifies the benefits of e-learning technologies. This finding suggests that digital literacy not only facilitates the adoption of e-learning tools but also enriches the quality of teacher-student engagement in virtual learning settings.

Conclusions: The study's results emphasize the necessity of improving teachers' digital literacy to enhance the overall quality of education and promote effective teacher-student interactions in elementary schools. Digital literacy serves as a critical enabler, allowing teachers to navigate and utilize e-learning tools more effectively. Consequently, targeted interventions to improve teachers' digital literacy should be prioritized as part of broader educational reforms. Additionally, the development of ICT infrastructure within schools is imperative for the successful implementation of e-learning initiatives. Providing teachers with

access to reliable digital tools and resources can further enhance their ability to deliver engaging and interactive virtual lessons. Moreover, tailored training programs focused on the practical use of e-learning platforms and digital teaching strategies can empower teachers to maximize the potential of ICT in education. By addressing these areas, schools can create a conducive environment for effective e-learning and foster stronger instructional interactions between teachers and students. The findings of this study contribute to the growing body of knowledge on the role of digital literacy in modern education and underscore its importance in adapting to the demands of the digital era.

NUMBER OF REFERENCES	NUMBER OF FIGURES	NUMBER OF TABLES
25	3	6

مقاله پژوهشی

بررسی نقش واسطه‌ای سواد دیجیتال معلمان در رابطه بین آموزش الکترونیکی و تعاملات آموزشی در مدارس ابتدایی شهر تهران

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چکیده

پیشینه و اهداف: پیشرفت‌های سریع در فناوری اطلاعات و ارتباطات (ICT) و ادغام آن‌ها در دستگاه‌های تلفن همراه، چشم‌انداز آموزش را متحول کرده و روش‌های نوآورانه‌ای را برای تدریس و یادگیری معرفی کرده است. این ادغام فناوری، نحوه تبیین و هدایت فرایند یادگیری را به‌طور قابل‌توجهی تحت تأثیر قرار داده است. معلمان، به‌عنوان تسهیل‌گران اصلی یادگیری، نقش محوری در جذب دانش‌آموزان در محیط‌های یادگیری الکترونیکی ایفا می‌کنند. با این حال، اثربخشی یادگیری الکترونیکی در تقویت تعاملات معلم و دانش‌آموز به عوامل متعددی بستگی دارد که یکی از مهم‌ترین آن‌ها سواد دیجیتال معلمان است. سواد دیجیتال نه تنها توانایی معلمان را در استفاده مؤثر از ابزارهای یادگیری الکترونیکی تعیین می‌کند، بلکه ظرفیت آن‌ها را برای ایجاد تعاملات آموزشی معنادار نیز افزایش می‌دهد. هدف این مطالعه بررسی نقش واسطه‌ای سواد دیجیتال معلمان در رابطه بین آموزش الکترونیکی و تعاملات آموزشی در مدارس ابتدایی شهر تهران است.

روش‌ها: روش تحقیق از نظر دست‌یابی به هدف از نوع کاربردی و از نظر شیوه گردآوری اطلاعات از نوع پیمایشی است. جامعه آماری به تعداد ۲۰۹۶۸ نفر معلم دوره ابتدایی در کل شهر تهران (مناطق ۱۹ گانه آموزش و پرورش شهر تهران) شامل ۱۸۸۲۴زن و ۲۱۴۴ نفر مرد بود. حجم نمونه براساس جدول مورگان ۳۷۶ نفر برآورد شد. روش نمونه گیری از نوع خوشه‌ای چند مرحله‌ای بود. در ابتدا شهر تهران به پنج منطقه جغرافیایی (شمال، جنوب، مرکز، شرق و غرب) تقسیم شد. پس از تقسیم‌بندی شهر تهران به مناطق جغرافیایی با دادن کد به‌صورت تصادفی از هر منطقه یک خوشه (منطقه) انتخاب شد. در مرحله بعد به‌صورت تصادفی از مناطق انتخابی با دادن کد از هر منطقه ۲۰ خوشه (مدرسه) به جهت رعایت توازن در مناطق انتخاب شد و برای اندازه‌گیری متغیرهای مورد مطالعه، سه ابزار معتبر مورد استفاده قرارگرفت که عبارتند از: پرسش‌نامه سواد رایانه‌ای، پرسش‌نامه یادگیری الکترونیکی و پرسش‌نامه تعامل معلم و دانش‌آموز. این ابزارها چارچوبی جامع برای ارزیابی سواد دیجیتال معلمان، اثربخشی یادگیری الکترونیکی و کیفیت تعاملات معلم و دانش‌آموز فراهم کردند. برای تحلیل فرضیات از مدل معادلات ساختاری و رگرسیون خطی استفاده شد.

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یافته‌ها: یافته‌های این پژوهش تأثیر مثبت یادگیری الکترونیکی بر تعاملات معلم و دانش‌آموز را تأیید می‌کند. علاوه بر این، سواد دیجیتال به‌عنوان یک عامل میانجیگری حیاتی شناسایی شد که این رابطه را تقویت می‌کند. به‌طور خاص، نتایج نشان داد که معلمان با سطح سواد دیجیتال بالاتر، مجهزتر به استفاده از سکوهای یادگیری الکترونیکی هستند و منجر به تعاملات آموزشی مؤثرتر می‌شوند. نقش میانجیگری سواد دیجیتال اهمیت آن را به‌عنوان یک مهارت بنیادین که مزایای فناوری‌های یادگیری الکترونیکی را تقویت می‌کند، برجسته می‌کند. این یافته نشان می‌دهد که سواد دیجیتال نه تنها پذیرش ابزارهای یادگیری الکترونیکی را تسهیل می‌کند؛ کیفیت تعامل معلم و دانش‌آموز را نیز در محیط‌های یادگیری مجازی غنی می‌سازد.

نتیجه‌گیری: نتایج این پژوهش بر ضرورت بهبود سواد دیجیتال معلمان برای ارتقای کیفیت کلی آموزش و ترویج تعاملات مؤثر معلم و دانش‌آموز در مدارس ابتدایی تأکید می‌کند. سواد دیجیتال به‌عنوان یک توانمندساز حیاتی عمل می‌کند و به معلمان امکان می‌دهد تا ابزارهای یادگیری الکترونیکی را مؤثرتر هدایت و استفاده کنند. در نتیجه، مداخلات هدفمند برای بهبود سواد دیجیتال معلمان باید به‌عنوان بخشی از اصلاحات آموزشی گسترده‌تر در اولویت قرار گیرد. علاوه بر این، توسعه زیرساخت‌های ICT در مدارس برای اجرای موفقیت‌آمیز ابتکارات یادگیری الکترونیکی ضروری است. فراهم کردن دسترسی معلمان به ابزارها و منابع دیجیتال قابل‌اعتماد می‌تواند توانایی آن‌ها را در ارائه درس‌های مجازی جذاب و تعاملی بیشتر تقویت کند. علاوه بر این، برنامه‌های آموزشی متناسب با تمرکز بر استفاده عملی از سکوهای یادگیری الکترونیکی و استراتژی‌های تدریس دیجیتال می‌تواند معلمان را برای به حداکثر رساندن پتانسیل ICT در آموزش توانمند کند. با رسیدگی به این حوزه‌ها، مدارس می‌توانند محیطی مناسب برای یادگیری الکترونیکی مؤثر ایجاد کرده و تعاملات آموزشی قوی‌تر بین معلمان و دانش‌آموزان را تقویت کنند. یافته‌های این مطالعه به مجموعه رو به رشد دانش در مورد نقش سواد دیجیتال در آموزش مدرن کمک می‌کند و اهمیت آن را در سازگاری با نیازهای عصر دیجیتال برجسته می‌سازد.

Introduction

In recent years, the global shift toward digital transformation in education has led to the emergence of new teaching approaches and learning paradigms. E-learning, as a significant advancement in educational technology, enables educators and students to engage in flexible and interactive environments that transcend physical limitations [1]. However, the effectiveness of e-learning largely depends on teachers' preparedness and their ability to adapt to these new environments, particularly in terms of digital literacy and digital competency [2]. The rapid advancements in information and communication technologies (ICT) and the proliferation of e-learning have driven educational environments towards digital interactions. This transformation necessitates that teachers possess adequate digital literacy to effectively utilize technology in teaching.

Teachers play a crucial role in fostering student engagement in e-learning activities. In the 21st century, educators must adapt to emerging needs, including the integration of information and communication technology (ICT) into their teaching practices. The use of ICT poses challenges in both traditional classroom settings and online environments, referred to as e-learning. Teachers are expected to use ICT to enhance students' learning experiences, guide their progress, provide solutions to potential problems, and support students in exploring and integrating new ideas [3]. E-learning refers to education delivered through electronic communication tools such as the internet, intranets, extranets, and hypertext. In the information age, e-learning has become one of the most prominent forms of learning, and its application in schools—particularly in Tehran—has expanded significantly [4]

Teacher-student instructional interactions, which lie at the heart of effective education, are influenced by various factors, including teachers' computer literacy. Digital literacy refers to an individual's ability to effectively use computers and technology. This includes skills

such as navigating computer programs, leveraging digital tools, and utilizing technology in the learning process. In developed countries, basic computer skills were already considered an asset by 2005 [5].

In traditional classrooms, teacher-student interactions involve direct communication, emotional support, and collaborative problem-solving [6]. However, the shift to virtual learning environments has introduced new complexities, as technology-mediated interactions may lack the immediacy and depth of face-to-face communication. Studies have shown that inadequate digital literacy among teachers can exacerbate these challenges, undermining the potential of e-learning platforms to facilitate meaningful interactions [7]

Theoretical frameworks such as Vygotsky's Sociocultural Theory and Bandura's Social Learning Theory emphasize the critical role of interaction and collaboration in learning. According to Vygotsky [6], learning occurs through social interaction within the "zone of proximal development," which can be supported by digital scaffolding in e-learning environments. Similarly, Bandura [8] highlights observation and modeling as essential elements of learning, processes that can be facilitated through multimedia tools and virtual collaboration in technology-enhanced education [9]

Despite the growing adoption of e-learning in Iran, particularly in Tehran's elementary schools, there is limited empirical research on the specific role of teachers' digital literacy in mediating the effectiveness of e-learning in promoting teacher-student instructional interactions. This gap is particularly significant given the challenges faced by Iranian schools, such as insufficient teacher training, inadequate infrastructure, and resistance to change [4]

The selection of the study variables—e-learning, teachers' digital literacy, and instructional interactions—is based on their interdependent and complementary roles in enhancing educational quality:

- E-learning represents a transformative tool in contemporary education.
- Teachers' digital literacy serves as a mediating skill necessary for the effective use of e-learning.
- Instructional interactions between teachers and students reflect the quality of the teaching-learning process and are used as the study's outcome variable.

In essence, e-learning alone is insufficient. Without adequate digital literacy, teachers may not be able to leverage the potential of digital platforms. Digital literacy enhances the quality and depth of educational interactions in virtual settings. The selection of these variables is also supported by previous studies and aligns with the educational needs of the country.

The increasing reliance on e-learning worldwide, especially in response to global disruptions such as the COVID-19 pandemic, highlights the urgency of understanding its dynamics and limitations. This research holds substantial significance for several reasons:

- Addressing Educational Gaps: By exploring the mediating role of computer literacy, this study aims to bridge gaps in teacher-student interactions, ensuring that e-learning achieves its intended outcomes in Tehran's elementary schools.

- Practical Implications: The findings will offer actionable insights for policymakers and school administrators to design targeted teacher training programs, improve digital infrastructure, and create supportive environments for e-learning.

- Theoretical Contributions: By integrating theoretical insights from Vygotsky and Bandura with empirical evidence from the Iranian

educational context, this study offers a localized perspective on global challenges, enriching the existing body of literature.

The theoretical significance of this study lies in its attempt to explain the role of teachers' digital literacy in enhancing educational interactions, drawing on Vygotsky's sociocultural theory and Bandura's social learning theory. Given the importance of teacher-student interactions in learning, this research holds significant theoretical implications.

This research aims to explore three interrelated variables in order to provide practical insights for improving the quality of education in Tehran's elementary schools. The significance of the study lies both in its theoretical contribution—by offering a locally adapted conceptual framework based on international theories—and in its practical value, by proposing strategies for empowering teachers.

Therefore, the central problem addressed in this study is that e-learning in elementary schools, when implemented without considering teachers' level of digital literacy, fails to foster effective and meaningful teacher-student instructional interactions. Therefore, the primary research question is: Does teachers' digital literacy mediate the relationship between e-learning and instructional interactions with students in elementary schools in Tehran?

Review of the Related Literature

Asare et al. [2] In a systematic review, investigated the effect of incorporating information technology in English language teaching in higher education settings. With the rapid growth of technology, its integration into education has attracted considerable attention. Bagherzadeh Homaee explored the influence of online education on teaching-learning interactions, finding that effective integration of e-learning platforms improved the quality of communication between teachers and students, provided that users had sufficient familiarity with digital tools [7].

Reich studied teacher-student relationships in digitally enriched environments, demonstrating how virtual learning spaces enabled collaboration, emotional support, and cultural exchange, thus fostering intellectual growth among participants [1]. Masoumi Fard conducted a study on the relationship between various types of interaction in e-learning and collaborative learning quality. The findings indicated a significant and direct correlation between different types of interactions (teacher-student, student-student, student-content, teacher-content, teacher-teacher) and collaborative learning quality in e-learning. However, no significant correlation was found between content-content interaction and collaborative learning quality [10]

Kahrizi et al. carried out a study titled "Assessing the Digital Literacy Level of Middle School Teachers." The research results revealed that, on average, teachers rated their digital literacy below the average level. Their proficiency in using the internet and Word was higher than in other general computer skills. No significant correlation was found between digital literacy levels and demographic characteristics such as gender, teaching experience, and educational background [5]. Mohammadi Baghmaleki and Yousefi conducted a study on the structural relationship between teacher-student Interaction, academic engagement, and student adjustment to school. The findings indicated that teacher-student interaction had a direct effect on students' academic engagement and adjustment to school. The indirect effect of teacher-student interaction on school adjustment, mediated by academic engagement, was also significant [11]

Moradi Mokhles et al. compared interaction levels in computer-based and web-enhanced learning environments. Their findings indicated that web-enhanced platforms provided superior opportunities for collaboration, particularly in teacher-student and peer interactions [8]. Jokar and Khase highlighted media literacy as a critical factor in the success of e-learning implementations. They emphasized the need for teacher training in digital tools to maximize the benefits of e-learning [4]. Kashvarz et al. conducted a study to investigate the digital literacy standards in virtual education. Their findings revealed that faculty members exhibited a relatively satisfactory level of proficiency in fundamental IT concepts, operating system management, and software applications such as Word, PowerPoint, Access, and Excel. Moreover, their internet usage skills were deemed satisfactory. The overall digital literacy score was also found to be at a reasonably good level [12]

Mansouri investigated the types of interactions between students and the curriculum in virtual environments. The results indicated that blogs were the most commonly used tool by students for both academic and non-academic purposes. Regarding interaction topics, the findings showed that the curriculum variable had a limited role in students' virtual interactions, as most students engaged primarily in recreational activities online [13]. Misbah et al. explored the relationship between teacher interpersonal behavior and student motivation in competency-based vocational education, using evidence from Indonesia. The results showed that teacher profiles in CBE and less-CBE schools were comparable, except for one unexpected difference in a specific dimension. Perceived teacher interpersonal behavior moderated the relationship between CBE and student motivation, with a greater impact in less-CBE learning environments. The necessary changes in the teacher's role remain unclear, hindering expectations of increased motivation in competency-based education [14].

Van den and colleagues investigated student engagement, focusing on the role of teacher beliefs and interpersonal teacher behavior in enhancing student interaction in vocational education. The study identified three distinct components of interaction: behavioral, emotional, and cognitive. The strongest relationships were found between the two dimensions of interpersonal teacher behavior and the three components of student interaction [15]. Bodur et al. focused on the role of teachers in web-enhanced learning environments in elementary schools. Their study underscored the importance of teacher guidance in overcoming the challenges of virtual learning platforms, particularly for younger students [3].

The reviewed literature highlights the significant role of digital literacy and technology-enhanced environments in fostering teacher-student interactions. Both national and international studies underscore that e-learning can bridge educational gaps by enhancing collaboration and engagement, provided that educators possess the requisite digital skills.

The studies reviewed exhibit similarities to the current research. For instance, Baqerzadeh et al [16], Baqerzadeh Hamaei [8], and Masoumi Fard [10] explored electronic learning and its impact on the quality of education, similar to the present study. However, a key distinction lies in the fact that none of these previous studies examined the impact of electronic learning on teacher-student interactions, nor did they investigate the mediating role of teacher computer literacy. This novel aspect sets the current research apart, contributing to the field by exploring the unique relationship

between electronic learning, teacher computer literacy, and instructional interactions. However, few studies have specifically investigated the mediating role of teachers' digital literacy in the context of elementary schools, particularly in Tehran. Moreover, prior research has not comprehensively explored how these interactions vary depending on varying levels of teacher digital competency.

The theoretical framework for this study is grounded in two prominent theories in education and learning sciences: Vygotsky's Sociocultural Theory and Bandura's Social Learning Theory. These frameworks provide a robust lens to understand the dynamics of e-learning and its influence on teacher-student interactions, with particular attention to the mediating role of computer literacy.

- Vygotsky's Sociocultural Theory: Vygotsky [6] emphasized the importance of social interaction as the foundation of learning and cognitive development. His concept of the Zone of Proximal Development (ZPD) is particularly relevant to e-learning environments. The ZPD refers to the difference between what a learner can achieve independently and what they can achieve with guidance from a more knowledgeable individual, such as a teacher.

In an e-learning context, digital tools and platforms can act as "scaffolds," facilitating the interaction between teachers and students within the ZPD. For instance, discussion forums, interactive simulations, and collaborative tools can enable teachers to provide tailored support to students, fostering deeper understanding and engagement. However, the effectiveness of such scaffolding relies heavily on teachers' computer literacy, as inadequate technological skills may hinder their ability to use these tools effectively [2]

Vygotsky's theory underscores that meaningful teacher-student interactions in e-learning require a deliberate effort to create socially interactive and cognitively enriching environments, mediated by technology.

- Bandura's Social Learning Theory: Bandura [8] proposed that learning occurs through observation, imitation, and modeling, which are particularly relevant in digitally mediated learning environments. He introduced the concept of reciprocal determinism, which suggests that personal factors (e.g., computer literacy), environmental factors (e.g., e-learning platforms), and behavior (e.g., teaching practices) interact dynamically.

In the context of e-learning, teachers model digital skills, collaborative behaviors, and critical thinking through their interactions with students. For example, a teacher adept at using multimedia tools can effectively demonstrate problem-solving techniques, inspiring students to replicate these behaviors in their learning processes. Bandura's theory highlights the need for teacher competence in technology to maximize the interactive potential of e-learning platforms [9]

Furthermore, Bandura emphasized self-efficacy, or an individual's belief in their ability to succeed in specific tasks. Teachers with high digital self-efficacy are more likely to engage with e-learning tools confidently, enhancing the quality of their interactions with students [2]

- Integrative Perspective: Combining these two theories provides a comprehensive framework for understanding the dynamics of e-learning and its impact on teacher-student interactions. Vygotsky's emphasis on social and collaborative learning complements Bandura's focus on modeling and self-efficacy. Together, they highlight the critical role of teachers' digital skills and confidence in facilitating interactive, effective e-learning environments.

For example, while Vygotsky emphasizes the need for scaffolding within the ZPD, Bandura explains how teachers' modeling of digital skills can encourage students to engage actively with

e-learning platforms. Both theories underscore the importance of addressing teachers' digital literacy as a mediating factor in e-learning success.

Drawing upon Vygotsky's and Bandura's theories, this research investigates the relationship between e-learning (independent variable), teachers' digital literacy (mediating variable), and teacher-student interactions (dependent variable). In other words, the theoretical framework of this study is a combination of Vygotsky's and Bandura's theories: Vygotsky emphasized the role of technology in facilitating interactions within the zone of proximal development, while Bandura highlighted the teacher's role in modeling and reinforcing students' self-efficacy in digital environments.

Conclusion: This theoretical framework establishes that teacher-student interactions in e-learning environments are influenced by the interplay of social, cognitive, and technological factors. Drawing on Vygotsky's Sociocultural Theory and Bandura's Social Learning Theory, this study hypothesizes that teachers' digital literacy mediates the impact of e-learning on instructional interactions. This framework guides the research in exploring how these theoretical insights apply to elementary school teachers in Tehran.

Method

This study is classified as applied research based on its intended purpose. From a methodological perspective, it is a descriptive and correlational type, and from a data collection perspective, it is a survey study.

Participants

The statistical population consisted of 20,968 elementary school teachers across all 19 educational districts in Tehran. Of this total, 18,824 were female and 2,144 were male. Based on Morgan's table, the sample size was estimated at 376. A multi-stage cluster sampling method was employed. Initially, Tehran was divided into five geographical regions (north, south, center, east, and west). After dividing Tehran into these geographical regions, one cluster (region) was randomly selected from each region by assigning a code. In the subsequent stage, 20 clusters (schools) were randomly selected from each chosen region by assigning codes to ensure balance among the regions. The research variables are as follows: independent variable: e-learning; dependent variable: teacher-student interactions; mediating variable: teachers' digital literacy.

Instruments

To measure the variables under study, three validated questionnaires were used, each with confirmed reliability and validity based on previous research:

- Digital Literacy Questionnaire: Developed based on the instrument by Bagherpour et al. [17]. This tool evaluates teachers' ability to utilize digital technologies in educational contexts. The Cronbach's alpha coefficient for this questionnaire was reported to be 0.76.

- E-Learning Questionnaire: Adapted from the questionnaire designed by Elahi et al. [18], this instrument assesses the extent of teachers' use, competence, and application of e-learning tools. The Cronbach's alpha coefficient for this tool was 0.88.

-Teacher-Student Interaction Questionnaire: Based on the instrument developed by Lourdusamy and Khine [19], this questionnaire measures the quality of instructional interactions between teachers and students. The reliability of this tool was confirmed with a Cronbach's alpha of 0.91.

Face validity of the questionnaires was established by consulting a panel of experts in communication and educational sciences.

In this study, face validity was used to test the validity of the measurement tool; the questionnaire was approved by a panel of communication and educational science experts. The questionnaire's reliability was determined using Cronbach's alpha coefficient, as shown in Table 1:

Table 1: Cronbach's alpha coefficient of the research variables

Variables	Cronbach's alpha coefficients
E-learning	0.88
Teacher-student instructional interaction	0.91
Computer literacy	0.76

To measure the variables, the digital literacy questionnaire of Baqerpour et al. [17], the e-learning questionnaire of Elahi et al. [18], and the teacher-student interaction questionnaire of Lardosamy and Kenny [18] were used Data analysis

A Kolmogorov-Smirnov test was first used to test the normality of the data distribution in the inferential statistics section. The hypotheses were tested using structural equation modeling and linear regression due to data normality.

Results and Findings

Based on the research findings, 32.3% of the studied samples were men, while 62.7% were women. The lowest frequency of samples (10.8%) was over 50, while the highest frequency (34.5%) was between 30 and 40. Among the samples, 2.8% held an associate degree with the lowest frequency, and 52.6% held a bachelor's degree with the highest frequency. At the lowest frequency, 4.9% of the samples had more than 25 years of experience, while at the highest frequency, 27.1% had 5-10 years of experience. As a result, the average capability was 3.03, the average application was 3.10, and the average e-learning was 3.07. Among the e-learning dimensions, the application had the highest average, while the capability had the lowest average. Leadership was rated at 3.47, helpfulness-friendliness was rated at 3.79, understanding was rated at 3.24, student responsibility-freedom was rated at 3.90, uncertainty was rated at 2.30, dissatisfaction was rated at 3.11, admonishment was rated at 2.29, strictness was rated at 3.64, and teacher-student interaction was rated at 3.21. E-learning was rated 3.61 on average.

Hypothesis testing

Since the significance level of the test error at the 0.95 confidence level is higher than 0.05 (Table 2), it can be concluded that the distribution of the research variables is normal, and parametric tests can be applied to test hypotheses.

Main Hypothesis: "E-learning affects teacher-student instructional interactions through the mediating role of teachers' computer literacy."

Table 2: Kolmogorov-Smirnov test results to determine the normality of the research variable distribution

Statistics	Teacher-student instructional interactions	E-learning	Computer literacy
The z-statistic for the Kolmogorov-Smirnov test	0.81	0.98	0,94
Significance level	0.29	0.16	0.19

A path coefficient of 62% was calculated for the impact of e-learning on teacher-student instructional interactions, as shown in Fig. 2 and

Fig. 3. In addition, the t-value for this parameter was estimated at 4.65. Based on a t-value of 5.12, the path coefficient of the mediating effect of teachers' digital literacy on teacher-student instructional interactions was calculated at 69%.

The structural equation modeling of the main hypothesis

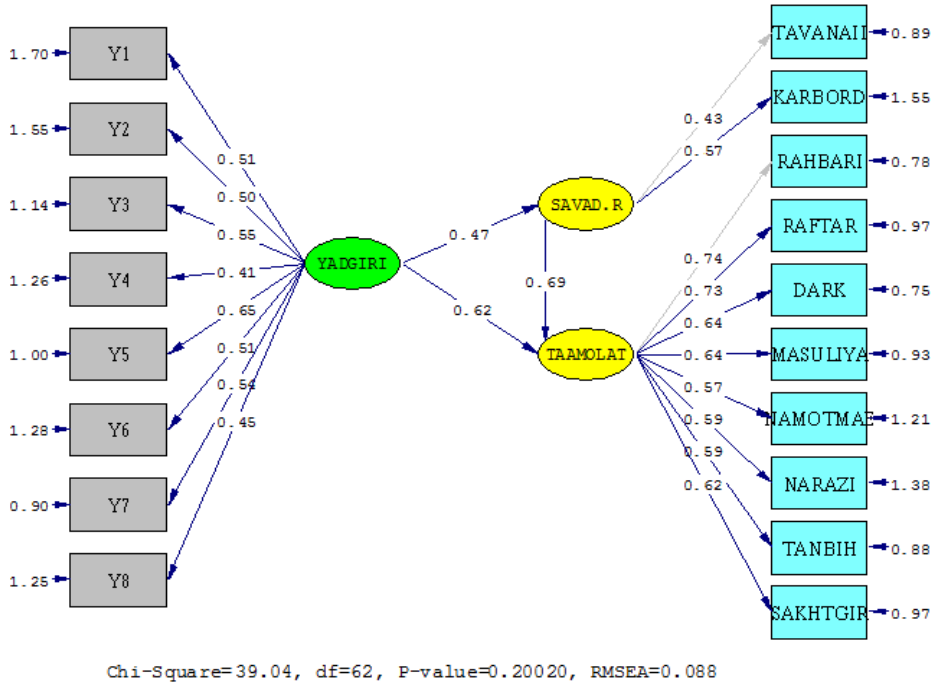

Fig. 1: The factor loadings for the main hypothesis

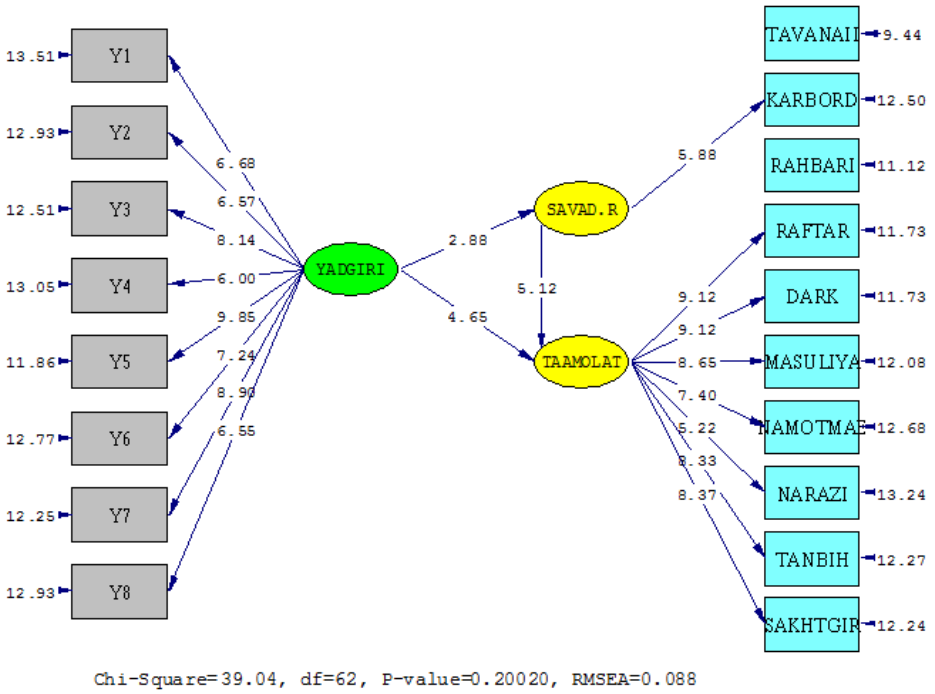

Fig. 2: T-values for analyzing the significance of the main hypothesis coefficients

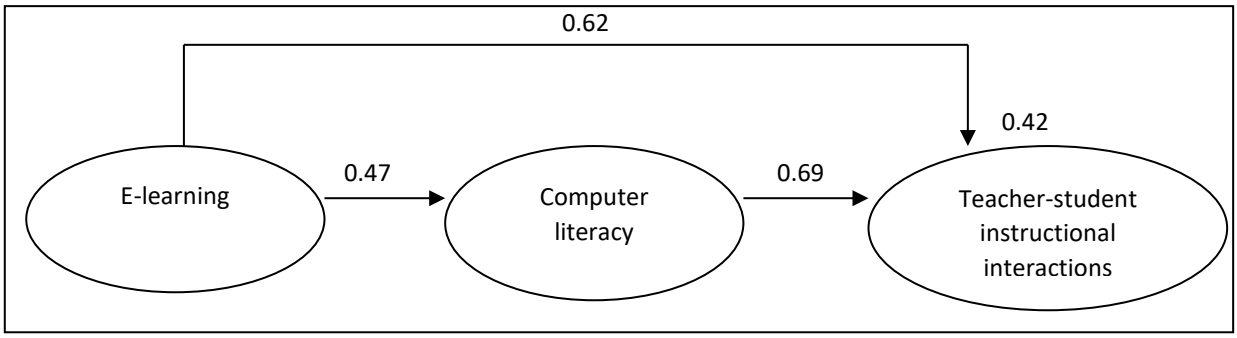

Fig. 3: The path coefficient of the main hypothesis

According to the path analysis shown in Fig. 3, e-learning and digital literacy explain 0.42% of the variance of teacher-student instructional interactions, with standard beta coefficients of 0.62 and 0.69, respectively. Therefore, the null hypothesis (H0) is rejected with a 99% confidence level. This coefficient is significant and positive, indicating that e-learning influences teacher-student interactions, with digital literacy playing a mediating role.

The findings of this study demonstrate that teachers' digital literacy plays a mediating role in the relationship between e-learning and teacher-student instructional interactions. As teachers' digital literacy increases, this effect will strengthen, and as teachers' digital literacy deteriorates, this relationship will weaken naturally. It is possible to infer this issue based on the significance and directionality of the effect of teachers' computer literacy. As a result, the main hypothesis is supported.

First sub-hypothesis: "E-learning significantly affects teacher-student instructional interactions."

Table 3: An overview of the regression model explaining the influence of e-learning on teacher-student instructional interactions

Correlation coefficient	R^2	Adjusted R^2
0.669	0.448	0.446

Table 3 shows a correlation coefficient of 0.66 and a coefficient of determination (R^2) of 0.44 between e-learning and teacher-student instructional interactions. Accordingly, e-learning accounts for 0.44 changes in teacher-student instructional interactions, while other variables account for 0.56 changes.

It can be concluded from Table 4 that, based on the significance level of the test error at a confidence level of 0.95, the first sub-hypothesis is supported, indicating that e-learning has a significant positive effect on teacher-student instructional interactions. Additionally, the BETA coefficient suggests that e-learning predicts 0.66 changes in teacher-student interactions.

Second sub-hypothesis: "Digital literacy significantly affects teacher-student instructional interactions."

Table 5 shows a correlation coefficient of 0.56 and a coefficient of determination (R^2) of 0.31 between digital literacy and teacher-student instructional interactions. Therefore, digital literacy accounts for 0.31 changes in teacher-student instructional interactions, while other variables account for 0.69 changes.

It can be concluded from Table 6 that, based on the significance level of the test error at a confidence level of 0.95, the second sub-hypothesis is supported, indicating that digital literacy has a significant positive effect on teacher-student instructional interactions. Additionally, the BETA coefficient suggests that

digital literacy predicts 0.56 changes in teacher-student instructional interactions.

Discussion

The findings of this study underscore the importance of e-learning and teachers' digital literacy in shaping teacher-student instructional interactions in elementary schools in Tehran. By applying structural equation modeling and regression analysis, this research has provided valuable insights into the relationships between e-learning, computer literacy, and teacher-student interactions.

Interpretation of Findings

- E-Learning and Teacher-Student Interactions: The study reveals that e-learning significantly affects teacher-student instructional interactions. The path coefficient of 0.62 indicates a strong positive relationship, confirming that e-learning environments, when integrated effectively, foster better communication and engagement between teachers and students. This finding aligns with previous studies, such as Reich [19] which emphasized the role of virtual learning in enhancing collaboration and intellectual growth. The study also found that e-learning accounts for 44% of the variance in teacher-student interactions, which highlights its substantial impact on educational practices in virtual environments.

Table 4: The results of the simple linear regression equation examining the influence of e-learning on teacher-student instructional interactions

Predictor variable	Unstandardized coefficients		Standardized coefficients	T	P
	B	SE	BETA		
Constant number	1.944	0.140		13.853	0.000
E-learning	0.534	0.033	0.669	16.177	0.000

Table 5: An overview of the linear regression model explaining the influence of digital literacy on teacher-student instructional interactions

Correlation coefficient	R^2	Adjusted R^2
0.563	0.316	0.314

Table 6: The results of the simple linear regression equation examining the effect of digital literacy on teacher-student instructional interactions

Predictor variable	Unstandardized coefficients		Standardized coefficients	T	P
	B	SE	BETA		
Constant number	2.169	0.167		13.000	0.000
Computer literacy	0.497	0.041	0.563	12.229	0.000

- The Mediating Role of Computer Literacy: Another key finding is the mediating effect of teachers' digital literacy on the relationship between e-learning and teacher-student instructional interactions. A path coefficient of 0.69 suggests that the effectiveness of e-learning is significantly enhanced when teachers possess high levels of computer literacy. This is consistent with the findings of Keshavarz et al. [12] who demonstrated that teachers' digital competencies directly correlate with the quality of instructional interactions. As teachers' digital literacy increases, their ability to navigate digital tools, create interactive learning materials, and foster meaningful engagement in e-learning platforms improves. Conversely, lower digital literacy levels can hinder effective use of e-learning resources, diminishing the potential for impactful teacher-student interactions.

- The Influence of Computer Literacy: The study also established that digital literacy itself has a significant effect on teacher-student instructional interactions, accounting for 31% of the variance in these interactions. The positive relationship between digital literacy and teacher-student interaction is in line with prior research [7] which showed that teachers who are more proficient in using technology are better able to facilitate communication and collaboration in online learning environments. This finding supports the idea that digital literacy is a crucial factor in the successful implementation of e-learning.

The results of this study are consistent with several studies in the literature, which highlight the critical role of digital competencies in enhancing teacher-student interactions in e-learning environments. For instance, Keshavarz et al. [12] found that digital literacy was a key determinant of the effectiveness of virtual education. Similarly, Bagherzadeh Homaee [7] demonstrated that a strong command of digital tools enhances communication between teachers and students, particularly in online learning settings. Moreover, this study's findings resonate with Vygotsky's Sociocultural Theory, which posits that learning is a social process facilitated by interaction. The use of digital scaffolding in e-learning environments enables teachers to support students' learning within their Zone of Proximal Development, but this process depends on the teacher's technological competence.

Furthermore, Moradi Makhless and colleagues [9] suggested that web-based platforms create better opportunities for teacher-student interactions, which also aligns with this study's conclusion that digital tools enhance the interaction quality between teachers and students.

Vygotsky emphasized the significance of social interactions and the concept of the "Zone of Proximal Development" (ZPD), where learning occurs when an individual interacts with more experienced individuals, such as teachers. In this study, a key finding is that teachers' digital literacy and e-learning skills significantly affect the quality of teacher-student interactions. This aligns with Vygotsky's theory, as teachers' digital literacy serves as a form of "scaffolding" that facilitates students' learning in the virtual environment. When teachers lack adequate digital skills, however, these scaffolding opportunities are hindered, as shown by the finding that "low digital literacy among teachers negatively impacts educational interactions."

More specifically, effective use of digital tools such as online platforms helps create opportunities for social and educational interactions in digital spaces. However, if teachers' digital literacy is insufficient, these interactions remain suboptimal, mirroring Vygotsky's argument that social interactions are

essential for cognitive development, which in turn requires adequate tools and scaffolding.

Bandura's Social Learning Theory also offers a relevant framework for understanding the dynamics of teacher-student interactions in e-learning. Teachers with high digital self-efficacy are better equipped to model effective use of technology, inspiring students to replicate these behaviors in their own learning processes. The findings of this study confirm the role of teacher competence in fostering engagement and collaboration in virtual learning environments.

Bandura's theory emphasizes learning through observation and modeling behaviors, particularly through the concept of "self-efficacy," which refers to an individual's belief in their ability to perform tasks successfully. In this study, the role of teachers' digital literacy as a key factor in improving educational interactions through digital modeling and independent learning is evident. These findings align with Bandura's theory because teachers, by demonstrating proficient use of digital tools, model effective behaviors for students and foster their self-efficacy in independent learning.

Based on the theoretical frameworks of Vygotsky and Bandura, the study findings can be analyzed as follows:

- Vygotsky's Theory suggests that teachers act as mediators of development within the Zone of Proximal Development. In digital learning environments, this mediation occurs through providing opportunities for students to engage with digital learning tools, which require teachers to possess adequate digital literacy. Without such literacy, teachers cannot effectively scaffold students' learning.
- Bandura's Social Learning Theory posits that teachers, by demonstrating appropriate behaviors and using digital tools effectively, serve as role models for students, enhancing their self-efficacy. As the study shows, teachers' digital literacy enables them to serve as effective role models, thus influencing students' ability to learn independently and with confidence.

Conclusions

This study supports the hypothesis that e-learning affects teacher-student instructional interactions through the mediating role of teachers' computer literacy.

In conclusion, the study suggests that teachers' digital literacy is crucial for enhancing educational interactions in digital learning environments. The findings underscore the importance of improving teachers' digital skills and providing adequate resources to foster positive learning outcomes in virtual settings. The study highlights a gap in the existing literature regarding the mediating role of digital literacy in elementary school contexts, particularly in Tehran, and contributes to filling this gap by emphasizing the role of teachers' digital skills in improving e-learning interactions in primary education. However, the study also highlights a gap in the literature—specifically, the limited empirical research focusing on the mediating role of digital literacy in elementary school contexts, particularly in Tehran. The findings of this study contribute to filling this gap by emphasizing the importance of teachers' digital skills in enhancing e-learning interactions in primary education.

This study has several practical implications for educational policymakers, administrators, and teacher educators:

- Teacher Training Programs: Given the mediating role of computer literacy, it is crucial to design targeted professional development programs that focus on enhancing teachers' digital competencies. Training should

emphasize not only the technical aspects of using e-learning tools but also pedagogical strategies for fostering meaningful interactions in virtual learning environments.

- Infrastructure Development: The findings also point to the need for improved digital infrastructure in schools. As e-learning platforms become an integral part of education, it is essential to ensure that both teachers and students have access to reliable internet and modern devices that support the effective use of educational technologies.

- Curriculum Integration: The study suggests that integrating e-learning tools into the curriculum should be done in a way that complements traditional teaching methods. Educators should be encouraged to use a variety of digital tools to create interactive and collaborative learning environments, thus fostering more engaging and productive teacher-student interactions.

This research is limited to elementary school teachers in Tehran, and factors such as technological infrastructure or student motivation are not directly examined. The research focuses on three variables: e-learning, teachers' digital literacy, and teacher-student interactions. Other factors, such as student motivation or cultural influences, are not examined. While this study provides valuable insights, it has several limitations. First, the research was conducted in a specific geographical region (Tehran) and within a particular educational context (elementary schools). Future studies could extend the research to other regions and educational levels to enhance the generalizability of the findings. Additionally, the study relied on self-reported data, which may be subject to biases. Future research could incorporate more objective measures, such as classroom observations or assessments of teachers' digital literacy. Moreover, this study focused on teacher-student interactions in e-learning environments but did not examine the impact of student factors, such as digital literacy or motivation, on these interactions. Future research could explore the reciprocal influence of both teacher and student competencies in shaping the effectiveness of e-learning.

Author's Contribution

Conflicts of Interest

"No conflicts of interest were declared by the authors."

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