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Determinants of Educational Technology Acceptance: Medical Teachers' Perception

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Abstract

Background: Educational technology is becoming an additional tool for interaction between students and teachers, along with traditional systems, in developing and improving the quality of education. The activities of faculty members have a direct impact on the overall quality of the educational process. Therefore, this study aimed to determine factors affecting educational technology adoption in the medical education context.

Methods: A sequential qualitative-quantitative mixed-method approach was used for this research. Firstly, a scoping literature review on related studies was conducted to extract involved factors in the adaption of educational technology. Next, using the three-round Fuzzy Delphi method, experts' perspectives about these factors were obtained. The Fuzzy Decision-Making Trial and Evaluation Laboratory (F. DEMATEL) was applied to investigate the relationships among these factors, and the Analytic Network Process (ANP) method was used to rank them.

Results: Conducting the scoping review resulted in extracting the factors affecting educational technology adoption in education, which were organized into nine indicators and four categories, including perceived usefulness, improved performance, social benefit, and facilitating processes through a three-round Delphi. The weights of these indicators were determined in the third and fourth steps of the study.

Conclusion: The findings of this study determined the most important factors affecting the acceptance of educational technologies, showed their relationship, and prioritized them. These findings can be used to integrate technology into the educational environment effectively. Investigating other factors according to the level of majors at the universities is recommended for future studies.

Keywords: Educational Technology, Delphi Technique, Perception, Technology Acceptance

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Introduction

With its modern and emerging technologies, the digital era has enabled the interconnection of the web, resources, and people, offering them the advantage of accomplishing tasks most efficiently (1). Educational institutions have begun to recognize and adopt the importance of technology in enhancing teaching and learning. The positive engagement of teachers plays a central role in acknowledging the value of a technology-driven educational environment. (1-3). According to the Innovation Diffusion Theory (IDT), adoption is a decision to fully use technological innovation as the best course of action. Technology acceptance, as the primary step of technology adoption, is an attitude towards

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↑What is "already known" in this topic:
Educational technology is a tool for improving the quality of education, and technology acceptance is the user's attitude towards this usage.

→What this article adds:
Saving time, accelerating learning, providing more variety in learning experiences, optimizing the educational process, facilitating the search and access to resources, facilitating learning opportunities, promoting new ways for knowledge creation, achieving educational goals, and productivity in the educational process are the most important factors influencing the acceptance of educational technologies.

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technology, and it is influenced by various factors (4). Integrating technology into education as an additional tool for the interaction between students and teachers other than the traditional system has some advantages, such as an increase in learning opportunities for learners, possibilities of massive information storage, and low cost of producing technology infrastructure (5).

The variables influencing the usage of technology have been studied extensively. Several models have been proposed to explain technology acceptance behavior (6-8). Moreover, numerous studies dealt with determinants related to technology acceptance in education (9-12). Furthermore, the Technology Acceptance Model (TAM) has become a leading framework in research. TAM includes various factors that explain behavioral intentions and the adoption of technology, either directly or indirectly, such as perceived usefulness, perceived ease of use, and attitudes toward technology. It has also been expanded by incorporating external factors like self-efficacy, subjective norms, and the conditions that support technology use. (13, 14).

Some researchers investigated the factors affecting the rate of technology adoption, including its characteristics and economic, sociological, organizational, and psychological variables. However, Educational systems encounter various challenges while adopting new technologies (12), which must be addressed to support the integration of modern technologies into the teaching and learning process. Meanwhile, we could not find any study considering all areas and attributes in this regard as an integrated model. More importantly, successful adoption depends on whether the individual or organization views the idea, behavior, or product as new or innovative. The behavior of faculty members, as the main adopters in the field of education, directly affects the quality of the educational process. Thus, understanding the factors that influence the acceptance and use of technology in teaching from their perspective is critically important. Moreover, the rate of adoption in any situation requires understanding factors and variables related to that context. Hence, the current study contributed to filling this gap by exploring the factors affecting educational technology adoption in the medical education context from faculty members' perspectives. It aimed to develop an acceptance model usable in medical education based on the Theoretical Acceptance Model (TAM) and additional factors that were obtained through faculty members' perceptions of this phenomenon.

Methods

The study used a sequential qualitative-quantitative mixed-method approach. It consisted of four steps, including performing a scoping literature review, conducting a Delphi technique process, investigating the relationships among factors using the Fuzzy Decision-Making Trial and Evaluation Laboratory (F. DEMATEL), and weighting factors using the Analytic Network Process (ANP). Firstly, the scoping literature review on related studies was conducted to extract involved factors in the adaption of educational technology. Next, using the Fuzzy Delphi method, experts' perspectives about the factors affecting the acceptance of educational technologies were obtained. It included three rounds using separate structured questionnaires for each round. During the third phase, the F. DEMATEL was applied to investigate the relationships among factors affecting the acceptance of educational technologies. In the F. DEMATEL method, a direct matrix was drawn, and through the experts' viewpoint, the intensity of the relationship and mutual influence of criteria were checked which had been depicted in a diagram. Finally, in the fourth phase, the ANP method was used, which is a more general form of the analytic hierarchy process (AHP) in multi-criteria decision analysis (15). AHP organizes a decision problem into a hierarchy consisting of a goal, decision criteria, and alternatives, whereas ANP represents it as a network, where the final weight of the criteria is calculated, and the outcome is presented in a table format (15).

Participants

20 e-learning or educational technology experts working as faculty members at Tehran University of Medical Science (TUMS) were the target population of the second step of the study. Purposive sampling methods were used in the determination of the participants of the study, which is common in qualitative research, and allowed us to produce maximum variation within the sample. The inclusion criteria for participation in the study were: (1) being an expert on the field of e-learning or educational technology in any department or college around TUMS; (2) voluntary participation in the study. participants that fit the inclusion criteria were contacted via e-mail. Meanwhile, they were invited to complete the questionnaires, which were developed in three Delphi rounds.

In the third phase, in which the F. DEMATEL was employed, we conducted interviews with seven professional experts who were selected based on their work experience of more than 10 years and being a faculty member at one of the medical education or e-learning departments at the university.

Data Collection and Analysis

The first stage of data collection was to accomplish a scoping literature review. PRISMA guidelines were followed for this review. The main question was, "What are the factors affecting technology acceptance in the academic environment?". It was searched in PubMed, Science Direct, Web of Science, and Scopus, in addition to Google Scholar as a search engine. The search operators included Boolean operators, parenthesis, and truncation and the keywords were: Technology Adoption Factors, Educational Technology, and Technology acceptance. The articles published between 1975 and 2020, being written in English, and relevant to the title and purpose of the research were set as inclusion criteria. The sample search strategy for Web of Science is: TS=(("Technology Adoption" OR "Technology acceptance") AND ("Educational Technology" OR "Education" OR "Faculty" OR " university" OR "postgraduate" OR "higher education").

The primary search provided 200 articles; among them, 76 articles were duplicates. After reviewing the abstract and titles of the selected papers, another 89 articles were excluded due to contradiction with the inclusion criteria. In

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the next step, 35 articles were selected to do a deep review. Among them 10 papers were excluded since they were not related to education and were not specific to technology adoption. So, 25 relevant articles were the main sample in the review step. Figure 1 shows the PRISMA diagram of this review.

During the second step of this research, the method was the Delphi technique, and based on the results of the previous step, a researcher-made questionnaire was completed by 20 experts. This step was implemented during three rounds. In the first round, using a 5-point Likert questionnaire, experts' perspectives about the importance of each criterion were collected. Based on experts' opinions at the rounds, the criteria were altered, so each round had a distinctive questionnaire. The validity and internal consistency of instruments were checked by experts' viewpoints and Cronbach's Alpha coefficient respectively. At the end of this step, the adoption factors related to educational technology were developed as a table. Table 1 shows details of each round in this step.

In the third phase, in which the F. DEMATEL was employed, using the pairwise comparison questionnaire, the experts expressed their insights about the intensity of the effect of the factors on each other (16). Finally, the ANP process method was used to prioritize the components of educational technology adoption factors.

Results

The results are shown in separate sections according to the research phases. Table 2 shows the results of the scoping review on relevant studies at step one. It revealed the variables consisted of nine categories, and each theme has its sub-categories.

In the second step, experts' perspectives about affecting factors in adopting educational technology were obtained through the Delphi method. The results of this stage were nine accepted indicators included in four categories: perceived usefulness, improved performance, social benefit, and facilitating processes. Table 3 illustrates the results of the second step of the study.

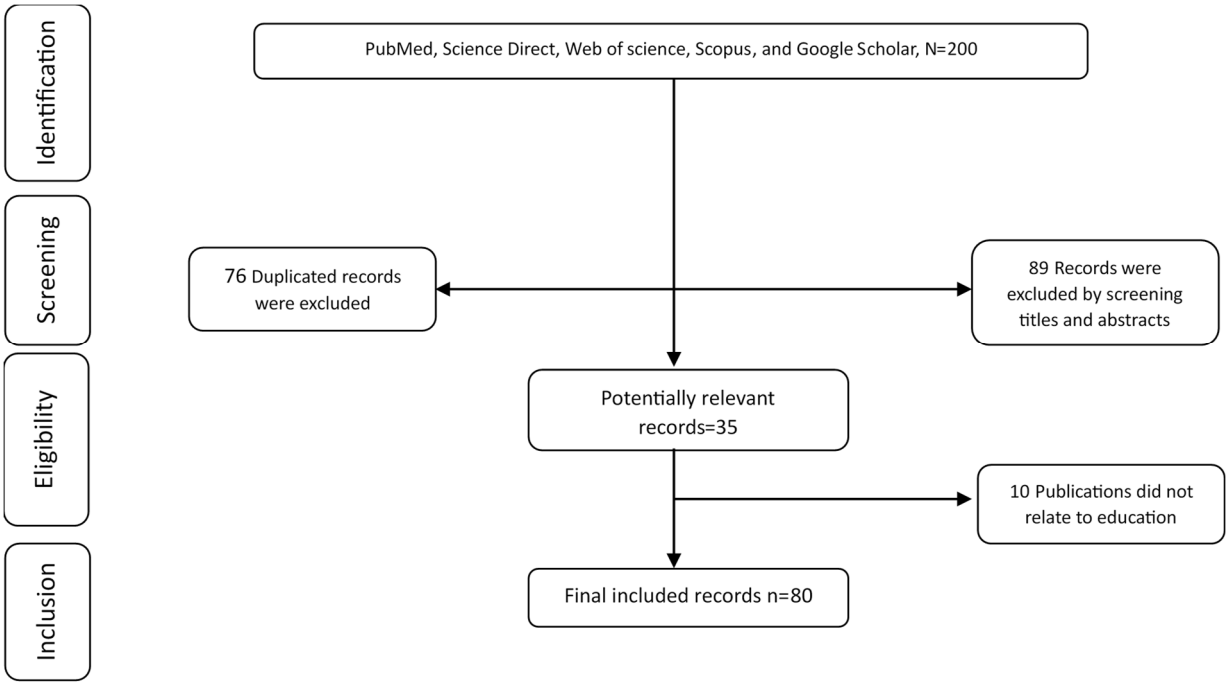

Figure 1. PRISMA diagram

Table 1. Experts' perspectives on affecting factors in the adoption of educational technology in medical education

Delphi rounds	Description of event
First round	- Email the identified criteria regarding the adoption of educational technology to experts to grasp their viewpoint and a questionnaire containing open questions - Document experts' perspectives
Second round	- Email a questionnaire containing closed questions following a Likert scale (1-5) to experts - Following the Pareto principle. Factors that scored above 4 were identified as acceptable factors and other criteria were excluded (17) - Ten factors with a threshold limit of more than 4 were accepted, and other items were excluded
Third round	- Email the previous results obtained from the second round to experts, including others' opinions - Gathering and finalizing experts' viewpoints according to the consensus and proximity of their opinions - Following the Pareto principle. Factors that scored above 4 were identified as acceptable factors, and other criteria were excluded. - Nine factors with a threshold limit of more than 4 were accepted, and one item was excluded - The consensus agreement of over 60% of experts about the criteria and stopping Delphi

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Table 2. Factors affecting educational technology adoption in education, determined through scoping review

Category	Sub-category: use of technology leads to the following:
Improve performance	Save training time, accelerate learning, improve decision making, save training time, promote autonomy and self-regulation, provide meaningful learning, provide more variety in the learning experience, and autonomy.
Facilitate educational process	Perceived easiness, facilitates the use of educational services, facilitates the search and access to various types of research, and facilitates student learning opportunities.
Social influence	Inform family and friends about the advantages of using technology, influence the public, improve professional position, promote new ways regarding knowledge creation, and support users more effectively.
Primary trust	Technology reliability and validity, providing more effective assistance to students.
Perceived easiness	Make educational activities simple and understandable, facilitate user tasks, more flexibility in training, increase students' motivation and interest toward learning, and facilitate cooperative learning among students.
Perceived security	Providing high security, ensuring the correct transfer of information, and feeling safety and confidence in technology custodians.
Compatibility	Compatible with user interest, compatible with user activities, compatible with user lifestyle, compatible with other educational methods, and compatible with various learning styles.
Mental norms	Encourage and recommend the use of technology by people who influence the user, consider the benefits of using technology by people who influence the user, and the user's perception of the importance of using educational technology services.
Perceived usefulness	Provide correct competition while cooperating among users, accelerate the achievement of educational goals, and optimize the educational process.

Table 3. Affecting factors in adaptation educational technology in medical education

No.	Indicator	Category
1	Improved performance (C1)	- Save training time (C11)
2		- Accelerate learning (C12)
3		- Provide more variety in the learning experience (C13)
4	Facilitating processes (C2)	-Facilitate the use of educational services (C21)
5		- Facilitate the search and access to various resources (C22)
6		- Facilitate learning opportunities (C23)
7	Social influence (C3)	-Promote new ways regarding knowledge creation (C31)
8	Perceived usefulness (C4)	- Accelerate the achievement of educational goals (C41)
9		- Optimize the educational process (C42)

In the third step, the results obtained from the previous step were exhibited in the form of a model that was developed by experts. The DEMATEL method was used to determine the relationships among the factors and the intensity of their effects. The fuzzy DEMATEL method is executed in the following steps. Firstly, the experts expressed their judgments on a linguistic scale, including "no influence", "very low influence", "low influence", "high influence", and "very high influence". Afterward, we defined the fuzzy initial direct-relation matrix and calculated the fuzzy normalized direct-relation matrix. Moreover, the experts were asked to determine a threshold value to filter out some negligible casual relationships. Finally, we calculated the values of the matrices D (sum of columns) and R (sum of rows) of the matrix that represented the influence on and the relationships with others. Some criteria that had positive values of D−R greatly influenced other criteria. Others had negative values of D−R and were the ones greatly influenced by other criteria. The value of D+R indicated the degree of relationship between each criterion with other criteria. Criteria with higher D+R values had stronger connections with other criteria, while those with lower values had fewer relationships. We determined the impact relationship chart that showed the causal relationships of the elements by using the values of D+R and D−R.

In this study, according to the sum of row (D) "saving training time" had the most influential effect on other indicators. On the other hand, the sum of columns (R) showed that "facilitating the search and access to various resources" was the most influenced indicator by others. Calculated D+R was the highest for "saving training time" which showed its great impact on the educational system (Table 4).

The ranking and prioritization of the criteria were done

Table 4. The influence on and the relationships with other indicators using fuzzy DMATEL

Category	R	D	D+R	D-R
Save training time (C11)	0.504	1.391	1.895	0.887
Accelerate learning (C12)	0.458	0.463	0.921	0.005
Provide more variety in the learning experience (C13)	0.898	0.532	1.43	-0.366
Facilitate the use of educational services (C21)	0.689	1.035	1.724	0.346
Facilitate the search and access to various resources (C22)	1.146	0.528	1.673	-0.618
Facilitate learning opportunities (C23)	0.775	0.483	1.258	-0.292
Promote new ways regarding knowledge creation (C31)	0.689	0.738	1.428	0.049
Accelerate the achievement of educational goals (C41)	0.694	0.706	1.4	0.011
Optimize the educational process (C42)	0.696	0.674	1.37	-0.023

$\boldsymbol{D} = \sum_{j=1}^{n} \boldsymbol{T}_{ij}$

$\boldsymbol{R} = \sum_{i=1}^{n} \tilde{\boldsymbol{T}}_{ij}$

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Table 5. Factors affecting technology acceptance with their weights and ranks calculated by ANP

Criteria	Weight	Rank
Save training time	0.000386	9
Accelerate learning	0.001174	8
Provide more variety in the learning experience	0.442182	1
Facilitate the use of educational services	0.005196	7
Facilitate the search and access to various resources	0.442142	2
Facilitate learning opportunities	0.019154	4
Promote new ways regarding knowledge creation	0.015624	5
Accelerate the achievement of educational goals	0.013728	6
Optimize the educational process	0.057430	3

in the fourth step, and the weight of each factor was obtained. For this purpose, we used the Super Decisions software (t) (For Windows version 2.10). Providing more variety in the learning experience obtained the highest rank. Table 5 shows the criteria, their weights, and ranks.

Discussion

Now that technology is being widely used in education, perhaps the most important question is how to best implement technology. Perhaps the most essential issue in the adaptation of technologies is how technology can best be exploited by instructors. While some educators eagerly want to work with technology, others point out how technology has sometimes cost the system a lot and achieved little. Teachers' attitudes are crucial factors in determining the role and effectiveness of technology (18-20). The results of this study demonstrated that four main interesting indicators affect the use and adaptation of educational technology, and each one of them encompasses impressive factors. It should be noted that the acceptability of obtained factors was prioritized, and the relationships between them were checked.

This study aligns with the Technology Acceptance Model, initially introduced by Davis (1985), which includes key variables related to user motivation (such as perceived ease of use, perceived usefulness, and attitudes toward technology) as well as outcome variables (behavioral intentions and technology use) (21). Both results from the recent research and what has been done by Davis are consistent with what has been found in a meta-analysis which explains technology acceptance well, it indicates that individual adoption is influenced by various subthemes categorized under several overarching themes: the attributes and accessibility of the technology, the differences in individual academics' attitudes, beliefs, and skills, the situational factors, and the strategies employed to integrate the technology, the individual, and the context during the adoption process (22). Although all of the themes are not completely the same as the findings of this research, overall, they are consistent together, as the most common determinants were related to learning experiences, learning opportunities, and the educational process. Contrary to the findings, others have shown the barriers to integrating technologies into the educational system, and they identify the most prevalent barriers according to the teachers' perception, so the most frequent barriers fall into four categories: personal, professional, institutional, and contextual (23-25). All these findings align with research indicating that a crucial factor in overcoming existing barriers is enhancing teachers' professional development in digital competencies, which includes aspects such as time management, training, pedagogical methods, experience, and teaching strategies that incorporate digital technologies (12).

The findings of the present research go beyond previous reports. It shows the relationship among variables. Moreover, it also prioritizes the variables based on the level of acceptability. On the other hand, the qualitative and quantitative methods were used. On the other hand, although this study examined the professors' insights about educational technology in medical education that was done at Tehran University of Medical Sciences, it can be generalized to other contexts. In addition, the data obtained in this study was collected using open questionnaires, which gives better results than a closed questionnaire.

Limitation

Although widely robust findings, this study suffers from some limitations due to not taking into account the gender, age, academic ranking, and other significant attributes of the participants. For this reason, for future research, we recommend a comprehensive study that aligns all the components within this vast area.

Conclusion

The results of this research identified the key elements influencing the acceptance of educational technologies, highlighted their relationship, and ranked them in order of importance. These insights can be utilized to seamlessly incorporate technology into educational settings. It is advised to explore additional factors based on the academic disciplines at universities in future studies.

Authors' Contributions

Conceptualization: A.M., M.Kh., R.M. Data curation: A.M., M.Kh., R.M. Methodology/formal analysis/validation: A.M., M.Kh., R.M., S.B. Project administration: A.M. Funding acquisition: not applicable. Writing the original draft: A.M., M.Kh., R.M., S.B. Writing, reviewing & editing: A.M., M.Kh., R.M., S.B.

Ethical Considerations

This study was approved by the Ethics Committee of Tehran University of Medical Sciences (No.: IR.TUMS.VCR.REC.1398.937).

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Conflict of Interests

The authors declare that they have no competing interests.

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