A survey research for e-learning readiness of faculty members during the COVID-19 pandemic: Technological, Pedagogical, and Content Knowledge Solution for e-Learning improvement from the viewpoint of faculty members

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Abstract

This study aimed to evaluate the e-readiness of faculty members during the pandemic COVID-19. It also identified the technological, pedagogical, and content knowledge solutions influencing the success of e-learning in medical education from the viewpoint of faculty members. Hundred faculty members working at Abadan University of Medical Sciences, Abadan, Iran participated in a mixed-method study including quantitative and qualitative phases. In the quantitative arm, the Likert-based Archambault & Crippen questionnaire was applied to measure the e-readiness of faculty members. In the qualitative arm, participants answered the 4 online open-ended questions consisting of three domains (pedagogical, technical, and content), and several themes were constructed from the gathered qualitative data. In quantitative analysis the Friedman test revealed that the knowledge of faculty members in the field of content knowledge was the most and in the field of technological knowledge was the least ($p \leq 0.001$). Besides, in the subjective interpretation of qualitative data, leadership and educational management were the most frequent themes. Moreover, regarding the pedagogical solutions, the focus principally was on the teaching-learning domain followed by revising curriculum planning. In addition, considering the content solution, the concentration predominantly was on the domain of the development of educational resources. From the viewpoint of faculty members, the challenge of the shift to e-learning and pedagogical, technological, and content solutions for e-readiness of faculty members can be resolved through planning and performing professional development programs and this cannot be achieved without effective leadership.

KEYWORDS: Medical Education, E-Learning, E-readiness, Mixed-method Study, Leadership.

1. Introduction

E-learning is an effective and appropriate educational approach for undergraduate clinical medical education (Delungahawatta et al., 2022). Using e-learning as an electronic medium for communication and interaction between faculty members and collegians is a natural and logical result of the needs of new generations especially in this situation (Awad & Siddik, 2019; Davidson & Rasmussen, 2006). With the onset of the coronavirus disease 2019 (COVID-19) pandemic, universities have inevitably taken steps to integrate e-learning into traditional education to continuity of learning for health professions students (Jin et al., 2021; Naciri et al., 2021; Sindiani et al., 2020). During this integration, medical schools rapidly digitized their instructional equipment and provided faculty members with their computer-based competence by continuing education opportunities and time resources (Hertling et al., 2023). However, e-learning potential requires a certain level of institutional readiness in human resources and infrastructure, which is not always provided in low- and middle-income countries. Therefore, performing

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efficacious e-learning in educational institutes is associated with the readiness levels of faculty members (T. Eslaminejad et al., 2010; Mariani et al., 2012). The institutional readiness for e-learning adaptation ensures the alignment of new tools with the educational and financial resources of setting (Frehywot et al., 2013). According to the results of a study conducted in 2019 on the readiness of countries to implement e-learning, Iran is ranked 59th out of 60 countries, sufficiently determining the importance of finding the strategies to improve this situation (Awad & siddik, 2019).

Several factors should be considered to assess e-learning readiness as a valuable option for providing education and training. Because, a medical university, as a knowledge-based organization, uses a wealth of resources to develop e-learning solutions, these factors must be taken seriously to reduce the risk of failure. One of the necessary factors to implement effective e-learning is analyzing the faculty members' pedagogical knowledge. In this study, readiness in terms of pedagogical solutions is referred to knowledge, attitudes, skills, and habits of faculty members in using appropriate approaches created through face-to-face interaction of the classroom to adapt to e-learning classroom and learners. In other words, pedagogical knowledge refers to the practices, processes, strategies, procedures, and methods of teaching and learning (T. Eslaminejad et al., 2010). Another major factor is an organization's readiness in applying technology and media in the instruction which are computers, the internet, digital video, etc. Faculty members will not be satisfied without sufficient skills and knowledge in applying technology.

Faculty members should have enough knowledge in subjects, such as providing technical support to students, employing multiple versions of a software package, using several operating systems, and the developed and integrated content-producing tools (WD, 2000). Results of a previous study demonstrated that not only the institutions must deliver a sufficient and reliable technical infrastructure to support e-learning activities, but faculty members and students should have technical skills to use e-learning tools. In this regard, faculty members must be both trained to use technology and also be able to organize and provide material with appropriate technology (Paloff RM, 2011). Studies have shown that acceptance of the use of technology in teaching and learning and successful implementation depends on a wide range of factors (Mumtaz, 2000) including training, leadership support, motivation to users, and policies for e-learning technologies (Landa et al., 2020). Valentine (2002) reported that the problems of using technology may be due to lack of knowledge and training, the attitude of the faculty member, or hardware difficulties.

Another major factor influencing faculty members' e-learning readiness is content which is the subject matter that is to be taught. An e-learning program requires content or topics focusing on faculty member's

activities. In addition, successful online learning education is influenced by learning experiences properly planned and made possible by knowledgeable educators (Eslaminejad et al., 2010). The final factor is the technological pedagogical content knowledge (TPACK) which is the connections and interactions between these three types of knowledge. TPACK is involved in the understanding of the complexity of relationships among students, teachers, content, technologies, and practices (Archambault & Crippen, 2009). Moreover, TPACK is the basis of good teaching with technology and requires an understanding of the representation of concepts using technologies, pedagogical techniques that use technologies in constructive ways to teach content; knowledge of what makes concepts difficult or easy to learn and how technology can help redress some of the problems that students face; knowledge of students' prior knowledge and theories of epistemology; and knowledge of how technologies can be used to build on existing knowledge and to develop new epistemologies or strengthen old ones (S, 2019). TPACK should look into the online teaching readiness of online teachers so that they are well equipped with the online pedagogical knowledge for effective teaching and learning. The findings showed a weak positive correlation between the domains of TPACK and technological readiness of online teachers. Moreover, among other domains in TPACK, the weakest correlation has been shown between technological knowledge and readiness (Rafiqah M. Rafiq K, 2022). This is reflected by the fact indicated in other studies (Gyaase PO, 2019), which mentions that even though the technological knowledge is high, the readiness of teachers to use technology effectively is still low. Considering this fact, technological knowledge does not correlate with the teacher readiness. However, teachers can understand and master TPACK with sufficient technological knowledge to engage students in learning. From this, it can be concluded that the domain of technological knowledge in TPACK is the domain that provides teachers with appropriate technological skills to use in the classroom (Rafiqah M. Rafiq K, 2022).

Although, this method has put a lot of pressure on faculty members and many efforts have been made in this regard, there are still concerns about how much this method has been effective in teaching students, and concerns have been raised about what strategies can be used to improve e-learning. Providing necessary facilities, such as e-learning software and forcing faculty members to provide time-consuming content cannot guarantee the effectiveness of an e-learning system. As, in this way, necessary programs are needed that should be arranged according to the e-readiness of the system (Lindquist & Long, 2011; Najimi et al., 2017).

Accordingly, this study was conducted to investigate the e-learning readiness of faculty members during the COVID-19 pandemic and the recognized constituents of pedagogical, technological, and content solutions influencing efficacious implementation of e-learning in the arena of medical education from viewpoint of faculty
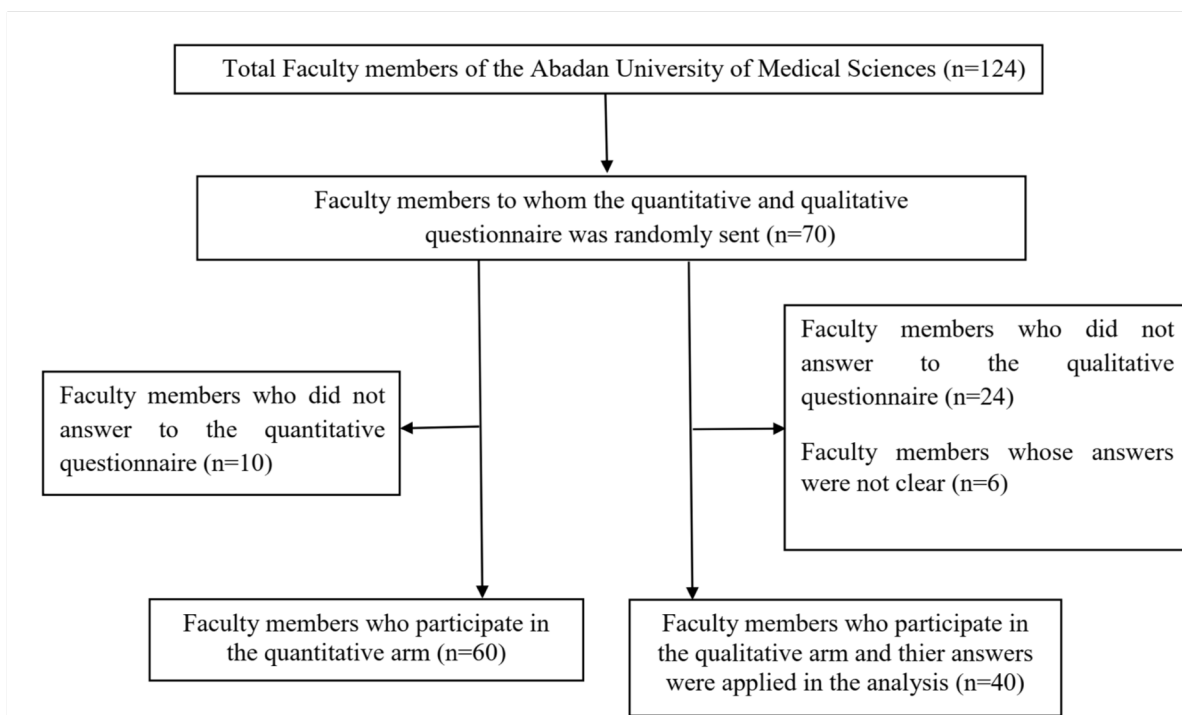
Figure 1 - Flow chart regarding enrollment of faculty members in the present study.

members to use the method that is more desired by the faculty members to improve e-readiness in each domain.

2. Materials and Methods

2.1 Research Approach and Context

This research used a mixed-method approach collecting and analyzing both quantitative and qualitative data from respondents. The mixed-method approach has been satisfactorily practiced in education-based research. Therefore, the collected and analyzed data can be more qualified and reliable (Junus et al., 2021). Considering the aim of the study, this research applied faculty members from a university located in the southwest of Iran who was representative of the population and selected participants with varied experiences and backgrounds. Quantitative data were gathered to measure the e-readiness of faculty members. Also, qualitative data were obtained aimed to investigate the pedagogical, technological, and content solutions of faculty members to improve e-learning readiness. This study was supervised by a faculty member who was responsible for the professor's empowerment unit, who had also participated in various medical education workshops and had a fellowship degree in the field of medical education, and had presented lectures at the medical education conference. The main collaborator of this project who was the director of the education development center, had the degree in three senior medical education courses and had presented a paper in the field of medical education, owned the top rank in

medical education conference, and also was a supervisor of thesis in the field of medical education.

2.2 Participants and sampling

This research was conducted on 70 academic teachers working at Abadan University of Medical Sciences, Abadan, Iran as faculty members. It was a sequential (Quantitative-Qualitative) mixed-method study, which was conducted from February-March 2020. Faculty members were selected by a voluntary and convenient online sampling technique. The quantitative component of the study consisted of a Likert-based questionnaire while a web-based semi-structured interview by completion of an online questionnaire were done in the qualitative component of the study to explore faculty members' experiences. In this technique, quantitative and qualitative questionnaires were designed in an online survey system called "DigiSurvey", to easily conduct at uncomplicatedness, low cost, time savings, and the enormous available population. Then, questionnaires were sent randomly to the participants relying on social media during the study, when the pandemic began in Iran and all universities had decided to host e-learning. All the answers were collected in "DigiSurvey" web-based written form. This research focused on faculty members from a university in south-western Iran, who held e-learning classes during the COVID-19 pandemic. Those who did not answer to the qualitative (n=24) or the quantitative questionnaire (n=10) and whose answers to the qualitative questionnaire were not clear (n=6) were excluded from the study. Finally, 60 faculty members

participated in the quantitative arm and 40 participated in the qualitative arm of the study (Figure 1). It should be noted that simultaneously with receiving the answers; they were analyzed and the purposive sampling method continued until reaching data saturation. In other words, the interviews continued until the researchers realized that continuing the interview would not add a new solution to the list.

2.3 Data Collection and Analysis

Quantitative arm

Quantitative data were taken from a Likert-based Archambault & Crippen questionnaire developed to evaluate online teachers' technological pedagogical content knowledge including 24 questions that was provided online for the first time to measure the respondent's perceptions of academic teachers' s e-readiness by using deductive and logical thinking. This questionnaire was based on the TPACK model, in four domains including pedagogical knowledge, technological knowledge, content knowledge, and ability to integrate the pedagogical, technological, and content knowledge (10). Responses were on a Likert-type scale, ranging from 1 = Poor, 2 = Fair, 3 = Good, 4 = Very Good, and 5 = Excellent. The construct validity of the questionnaire has been established in a previous study on online teachers undertaking the expert review and two rounds of think-aloud piloting (Archambault LM, 2010).

Quantitative data were analyzed using Friedman's test procedure for analysis of variance by ranking the knowledge of faculty in different fields i.e., observed rank scores obtained by numerical outcomes in the lack of strong normal distribution assumptions. The test was supported by IBM SPSS statistics software version 26 which is routinely discussed in textbooks on nonparametric statistics (Eisinga et al., 2017).

Moreover, nonparametric correlations were applied to determine the association between domains.

Qualitative arm

Through the web-based questionnaire, each faculty member underwent a semi-structured interview about his/her suggestion to improve his/her e-learning readiness. At the beginning of the questionnaire, a text was written to explain the purpose of the research. The qualitative questionnaire consisted of 4 open-ended questions investigating the faculty member's viewpoint about pedagogical, technological, and content solutions to improve e-learning readiness and the way to integrate e-learning in conventional teaching (Houshmandi et al., 2019). Participants were free to respond to questions. The qualitative data obtained from the interviews were coded to discover their patterns. They were then interpreted using the method of subjective interpretation of qualitative data along with a systematic classification and coding process to analyze the answers which were inspired by Khanipoor et al (2017). Conventional

content analysis was done to extract the themes. In the other words, the preconceived categories were not used. The texts were read repeatedly to understand them and determine meaning units. Then, the meaning units were integrated to specify the codes and neglect meaningless units. The results of subjective interpretation of qualitative data were used to determine pedagogical, technological, and content solutions to improve e-learning readiness of faculty members.

3. Results

Table 1 summarizes the demographic characteristics of participants. The faculty members were mostly aged between 30-39 years old. Fifty-six percent of faculty members had a teaching experience between 1 - 5 years, while 16% of them had more than 10 years of teaching experience. Also, 60% of the participants were instructor, 35 of them were assistant professors, and 5% of them were associate professors.

Table 1 - Demographic characteristics of the participants.

Attribute	Category	n (%)
Location	Faculty of medicine	24 (34%)
	Faculty of nursing	21 (31%)
	Faculty of paramedical	13 (18%)
	Faculty of health	12 (17%)
Discipline	Medicine	10(14%)
	Nursing	21(30%)
	General health	4(6%)
	Environmental health	5(7%)
	Laboratory sciences	4(6%)
	Health Information Technology	3(4%)
	Basis science	14(20%)
	Professional Health	3(4%)
	Other	6(9%)

Quantitative interpretation of faculty members' e-readiness

As shown in Table 2, the Friedman test revealed that the knowledge of faculty members in the field of content knowledge was the most and in the field of technological knowledge was the least ($p \leq 0.001$).

Also, Spearman's correlation analysis showed that technology content knowledge (r=0.8, $p \leq 0.001$) and technological pedagogical knowledge (r=0.9, $p \leq 0.001$) have a positive strong relationship with technological pedagogical content knowledge. Moreover, technological knowledge has a positive weak relationship with pedagogical knowledge (r=0.3,

$p<0.05$) and pedagogical content knowledge. (r=0.4, $p<0.05$) (Table 3).

Table 2 - Mean rank of e-readiness domains (the Friedman test was applied to determine the mean rank of e-readiness, $p \leq 0.001$).

E-readiness domains	Mean rank	SD
Pedagogical knowledge	4.11	0.537
Technological knowledge	2.59	0.831
Content knowledge	5.19	0.536
Technology content knowledge	4.39	0.686
Pedagogical content knowledge	4.94	0.558
Technological pedagogical knowledge	3.44	0.735
Technological pedagogical content knowledge	3.34	0.696

Qualitative interpretation of solutions for e-learning improvement from the viewpoint of faculty members

In the method of subjective interpretation of qualitative data, 151 initial meaning units and 72 codes were obtained from the answers given to 4 questions. These codes were categorized into 8 core themes according to their similarities. Themes extracted from the codes were repeated in all questions, but their repeatability was different and fewer themes were extracted from some questions. The ranking of themes based on repetition in all 4 questions is shown in Table 4.

In question No.1 (pedagogical solutions), the focus primarily was on the teaching-learning domain followed by revising curriculum planning. Examples of the extracted codes related to the teaching-learning domain were "using images in content presentation and designing of analytical homework, quizzes, and forums". Also, "deduction of semester units", "transparency of educational context", and "expression of educational goals" were examples of codes extracted related to the domain of revising curriculum planning. Extra examples are given in Table 5.

In question No.2, the focus primarily was on the domain of leadership and educational management. Examples of the extracted codes related to this domain were "using experiences of other universities" and "creating financial incentives and privileges in various regulations for faculty members". Extra examples are given in Table 6.

In question No.3 (content solution), the concentration primarily was on the domain of the development of educational resources. Examples of the extracted codes related to this domain were providing e-learning training booklets and introducing e-books to students, and providing them with access to electronic library systems. Extra examples are presented in Table 7.

In question No. 4 (suggestions to integrate e-learning in teaching), concentration was equally on the domains of leadership and educational management, revising curriculum planning, and development of educational resources. Examples of the extracted codes related to this domain were "creating a virtual education unit", "hiring virtual education specialists", "adapting lesson plans based on principles of e-learning", and "using the integrated system". Extra examples are given in Table 8.

Domains	PK	TK	CK	TCK	PCK	TPK	TPCK
PK	1.000	.299*	.673**	.545**	.670**	.599**	.559**
TK	.299*	1.000	.411**	.568**	.386**	.550**	.621**
CK	.673**	.411**	1.000	.754**	.768**	.639**	.681**
TCK	.545**	.568**	.754**	1.000	.717**	.761**	.801**
PCK	.670**	.386**	.768**	.717**	1.000	.732**	.727**
TPK	.599**	.550**	.639**	.761**	.732**	1.000	.873**
TPCK	.559**	.621**	.681**	.801**	.727**	.873**	1.000

Table 3 - The correlation between e-readiness domains.

PK: pedagogical knowledge; TK: technological knowledge; CK: content knowledge; TCK: technology content knowledge; PCK: pedagogical content knowledge; TPK: technological pedagogical knowledge; TPCK: technological pedagogical content knowledge; * Correlation is significant at $p<0.05$; **Correlation is significant at $p<0.001$.

Table 4 - Ranking of themes based on repeatability in 4 questions.

Rank	Extracted themes according to their importance
1	Leadership and educational management
2	Development of educational resources
3	Empowerment of faculty members, teaching-learning, and development of educational platform
4	Revising curriculum planning
5	Evaluation of faculty members
6	Evaluation of students

Table 5 - Examples of the codes and themes for question No.1 (pedagogical solutions).

Codes	Themes
Composing facilitative regulations	Leadership and educational management
Interactive e-learning	Teaching-learning
Providing a suitable physical platform and hardware facilities	Development of educational platform
Defining the system of encouragement and punishment for faculty members	Evaluation of faculty members

Table 6 - Examples of the codes and themes for question No.2 (technological solutions).

Codes	Themes
Increasing bandwidth and facilitating students' access to educational systems	Development of educational platform
Using virtual reality technologies for laboratory lessons	Development of educational resources
Using simple and up-to-date content-producing software	Development of educational platform
Setting up a content-producing studio and providing the necessary hardware	Development of educational platform

Table 7 - Examples of the codes and themes for question No.3 (content solutions).

Codes	Themes
Holding training workshops in the field of e-learning	Empowerment of faculty members
Applying diverse, up-to-date, engaging, and high-quality educational content	Teaching-learning
Presenting key and practical points of the educational content	Revising curriculum planning
Sharing experiences in various fields of teaching, students' assessment etc.	Empowerment of faculty members

Table 8 - Examples of the compressed meaning units and codes for question No.4 (suggestions to integrate e-learning in teaching).

Codes	Themes
Providing incentive support for faculty members using e-learning methods	Leadership and educational management
Creating a virtual education unit and hiring virtual education specialists	Development of educational platform
Construction of classrooms equipped with electronic devices	Development of educational platform
Developing skills in academic members by holding empowerment workshops	Empowerment of faculty members

4. Discussion and conclusion

This study was performed to determine the e-readiness and identify the most important factors influencing the e-readiness regarding pedagogical, technological, and content solutions to implement e-learning from the viewpoint of faculty members in a university of medical sciences in Iran. The results of quantitative data showed that the content knowledge of faculty members was the most and their technological knowledge was the least. Moreover, technology content knowledge and technological pedagogical knowledge indicated a positive strong relationship with technological pedagogical content knowledge. Besides, technological knowledge displayed a positive weak relationship with pedagogical knowledge and pedagogical content knowledge. Accordingly, a similar study on the universities of Medicine in Iran reported that the readiness of faculty members in the technical domain was less than the readiness in the pedagogical domain and continuous training suggesting the need to improve the IT knowledge of faculty members (Tahereh Eslaminejad et al., 2010). Also, in a similar study, the e-readiness of faculty members working in Ardabil University of Medical Sciences, Ardabil in northwestern Iran was identified and reported that technological pedagogical knowledge was the first and pedagogical knowledge was the last priority of the knowledge needs among faculty members (Houshmandi et al., 2019). These results revealed the need for a basic understanding of the compound issues regarding the official and principled uses of technology among faculties. Because consciousness from the educational strategy allows the online faculty members to adopt a grounded design approach, the use of active learning method and compound strategy in course design and assessment of e-learner was one of the critical components that were emphasized by faculty members. This was because in an online learning system the faculty members are not always present to conduct teaching; thus, it is essential to have good e-material courses and clear instructions (Vesely et al., 2007).

It is important for the educator to adapt multiple teaching strategies to meet the needs of diverse learning styles in an online class. Therefore, faculty member readiness is one of the significant requirements for improving the e-learning system, because other critical factors on successful e-learning, such as learning resources design and improve students' capacity to prepare for online learning are correlated to this aspect (Piskurich, 2003).

It is reported that faculty members must pay consideration to the educational strategy principles in their online course design because basic knowledge and understanding of the legal and ethical use of technology are necessary to deliver online courses. Nevertheless, they require more time and greater incentives for designing and developing an e-learning course. However, there are some differences compared to the traditional method, for example, how the online curriculum is delivered is new and very much different from the traditional approach. This is a critical factor influencing the success of e-learning. It is not only related to e-learning content and providing a volume of texts, Word, or PowerPoint documents but is also an essential element of e-learning in the teaching development that underscores communication and interaction with students(Driscoll, 2010; Lee & Owens, 2004).

Also, the results of qualitative data revealed that the development of the teaching-learning process and revising of curriculum planning are the most important pedagogical solutions to improve the e-learning readiness of faculty members. Results of a meta-analysis investigating the efficiency of discussion plans in online learning showed that "rich pedagogical strategies" have the most effect on students performance compared to when they involve in a conventional online discussion. Rich pedagogical strategies included faculty member participation, communication with students, and facilitation of students collaboration as well as constant observing and adaptable discussions, which all involve teaching-learning topics (Darabi A, 2013). Furthermore, using e-learning is recommended to develop the teaching-learning process (Benta et al., 2015).

Research has shown that curriculum planning is one of the factors hindering integration of e-learning into course delivery (Dagada R, 2013). Mirzaei et al. pointed out that the development of information and communication technology (ICT) in Iran is dependent on the improvement of social and information-technology-based curriculum planning (Mirzaei, 2015). Also, not only presentation of the online curriculum is novel and very dissimilar from the traditional method, but also curriculum revision is one of the basic elements of e-learning and an important factor in its success. Moreover, curriculum revision is associated with e-learning content and presentation of Word or PowerPoint documents. Besides, it focuses on communication and interaction with students (Eslaminejad et al., 2010).

Also, the results of the present study showed that leadership and educational management was the most frequent domain of technological solutions identified for assessing the e-learning readiness of faculty members and was suggested as a solution to integrate e-learning in teaching. Thus, it can be considered a crucial aspect of the e-learning readiness of faculty members. In line with our study, Altunisik identified that leadership is an important factor to guarantee the implementation of e-learning in an institute (Altunisik, 2012). Also, Dembowski stated that universities must do leadership process properly to implement educational programs effectively and achieve training goals. A leader must set goals and inspire employees to move in that direction and motivate them to work towards goals and overcome challenges (Dembowski, 2006). Moreover, several studies have reported that success in this evolution and moving towards e-learning depends on how it is managed (De Coster et al., 2008; Salmi, 2011; Zhu & Zayim-Kurtay, 2018), and management deficiencies in educational technologies lead to program failure (Kentnor, 2015).

Besides, our results demonstrated that content solutions for improving e-learning readiness may be focused on the development of educational resources. Thus, educational content and materials are recommended to be in the open-access form to education and knowledge [open educational resources], which is referred to as a learning management system and special services offering videos and live streaming, such as apps and e-book systems (Ebner M, 2020). The used content should be interactive, up-to-date, relevant, and user-friendly (Mariani et al., 2012).

In the present study, the factors influencing the integration of e-learning in the educational process were also identified, focusing on the development of educational resources, leadership and educational management, and revising curriculum planning. Resource development is one of the most important necessities lack of which will disrupt the proper execution of the program (Jafari et al., 2020; Meggs et al., 2012). Designing an e-learning framework needs careful analysis and investigation of resources available to the institution (Kituyi G, 2013). According to the existing literature, O'Doherty et al., (O'Doherty et al., 2018) found that the development and implementation of e-learning resources along with educational strategies and skills are among obstacles and solutions in this context. Educational resources are developed by having trained human resources, allocating financial resources, and supporting all stakeholders concerning their needs, all of which are needed to create appropriate mechanisms by e-learning managers. Faculty members as a valuable human resource to continue participation in the development of e-learning should receive support from institutions (Perlman et al., 2014). This support is essential for the future success of the organization. Therefore, an organizational strategy is needed to facilitate key skills and scientific methods when implementing online learning (Bediang et al., 2013).

The findings of this study showed that educational programs should be conducted to improve the e-readiness of faculty members, especially in the field of technological knowledge. Also, improving technological knowledge may be related to increasing the pedagogical knowledge, content knowledge, and pedagogical content knowledge of faculty members. These findings guide the faculty empowerment programs and help the university to know in which areas it should spend more time and cost to strengthen the faculty members.

Because, e-learning readiness in the field of medical education is a novel meaning and is influenced by pedagogical, technological, and content factors, it is important that medical universities and their faculty members be aware of solutions for the improvement of e-learning readiness.

In the meantime, there is a need for a culture that works to improve e-learning readiness among employees. In this way, faculty members will be better organized to challenge in this digital age. Thus, the challenge of the shift towards e-learning and pedagogical, technological, and content solutions for e-learning readiness of faculty members can be handled through planning and performing professional development programs and this cannot be achieved without effective leadership and educational management.

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