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How to create a successful mobile learning strategy for medical education during lockdowns?

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Abstract:

BACKGROUND: Mobile learning has played an important role during the COVID-19 pandemic and medical schools now consider it as an effective educational method in current and future crises. In this qualitative study, an attempt was made to demonstrate the principles of designing a mobile learning strategy in medical education from the perspective of experts.

MATERIALS AND METHODS: The study was conducted by the qualitative content analysis method. The data were collected from July 2022 to Feb 2023. Twelve participants were included in this study from Iran's medical universities, consisting of two members of the Higher Council of Virtual Education, three educational directors, three clinical faculty members, two faculty members specializing in e-learning and medical education, an educational vice, and a dean. Data were collected using semi-structured interviews and analyzed by Granheim and Lundman's (2004) method.

RESULTS: Out of twelve participants in the study, eight (66%) were males and four (44%) females. Data were classified into eight categories and one theme. Based on the participants' experiences, the main theme, that is, "the principles of medical education design in mobile learning," included pedagogical component, interactive design, effective and comprehensive analysis, achieving objectives with the mobile learning platform, generating micro- and interactive e-content, teaching-learning interactive methods, course implementation and interactive evaluation at both micro- and macro-levels.

CONCLUSION: Data analysis revealed that in addition to the eight principles in the medical education design in mobile learning, the participants prioritized the two principles of pedagogical component and interactive design over other principles in educational design. Using a successful mobile learning strategy in situations of restrictions limiting physical presence may improve the quality of medical education.

Keywords:

Content analysis, medical education, mobile learning, qualitative study

Introduction

The use of mobile devices, especially smartphones, for social, personal, and educational purposes has increased during the last decade. International organizations, including the United Nations and UNESCO, have emphasized that many significant technological changes will be part of the future leading to new learning scenarios such as mobile learning.^[1]

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The first studies on mobile learning began around 2000. Many studies have been conducted since along with the development of mobile learning strategies in many educational settings.^[2]

Mobile learning is defined as any type of learning strategy using mobile devices creating flexible learning opportunities and greater mobility.^[3] Mobile learning complies with many educational objectives, such as independent learning, self-directed

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learning, learning at any time and any place. Moreover, mobile learning accommodates personal preferences between students and provides more tangible examples by using computer facilities, cooperative learning, as well as the possibility for rapid evaluation and feedback.^[4] In mobile learning strategy, the student is constantly searching, accessing, and retrieving data on a specific topic.^[5]

Mobile learning provides new boundaries for the use of educational technology and is a useful mechanism for enriching the learning experience of university students.^[6] Thus, academic institutions, including medical schools attempt to adapt to the rapid technological, communication, and information advances.^[7]

Several medical schools such as the University of Melbourne and Johns Hopkins have included the use of mobile technologies in their programs.^[7,8] The widespread use of these technologies by medical students, faculties, and patients has expanded the opportunities for medical education activities and diminished the gap between medical education and clinical practice.^[9] Some studies have shown that mobile technologies may potentially enhance the use of evidence-based medicine and clinical decision-making^[10] as well as improve students' performance,^[11] quality of teaching,^[12] and students' knowledge.^[13] Also, there is a tendency to use mobile technologies in promoting learning in the preclinical^[14,15] and clinical settings.^[16]

As an educational strategy, mobile learning has also played an important role during the COVID-19 pandemic and medical schools now consider it as an effective educational method in current and future crises. Therefore, expansion of mobile learning infrastructures will be one of the key strategies to meet global risks in the future.^[17,18]

Recent reviews in medical education show that mobile learning is particularly effective in acquiring new knowledge and skills.^[19-21] However, more research is needed on the effectiveness of mobile learning in medical education as well as the discovery of key principles for the instructional design of this type of strategy to improve learning outcomes.^[20,21] Mobile learning is complex and multidimensional and should be studied in a social and cultural context. To the base of our knowledge, there is no study about instructional design in mobile learning according to Iran's medical university context.

This study investigated experts' understanding of key principles for instructional design and implementation of mobile learning in medical education considering cultural and social dimensions of the Iranian society.

Materials and Methods

Study design and setting

This qualitative study was conducted by a content analysis approach. Qualitative content analysis is a suitable method to examine experts' experiences and attitudes toward a particular subject.^[22,23]

Study participants and sampling

Of the twelve participants in this study, 66%^[8] were males and 44%^[4] were females. The minimum and maximum ages of participants were 35 and 57, respectively.

The population of this study included members of the Higher Council of Virtual Education Universities of Medical Sciences and different levels at medical universities (dean, educational vice and director, faculty members) in Iran experienced in teaching or supervising mobile learning during the COVID-19 pandemic. Sampling was purposive and continued until reaching data saturation^[24]. A total of twelve participants were included in the study [Table 1].

Data collection tool and technique

Data were collected through semi-structured in-depth interviews. Initially, interviews were conducted in various places such as the faculty room, office of the educational vice, office of the director of the e-learning group based on participant's preference, but during the COVID-19 pandemic, interviews were conducted through Skype and WhatsApp.

All interviews were recorded and transcribed verbatim immediately after the interview. The interview guide included questions such as "How would you describe your experiences in mobile learning?", and "How did you design your educational environment during COVID-19?"

Following, interviewees were asked to provide more examples asking probing questions such as "What do

Table 1: Demographic participant characteristics

No	Age	Gender	Position
1	45	Male	Dean
2	39	Male	Faculty member
3	56	Female	Member of the Higher Council of Virtual Education
4	48	Male	Educational vice
5	43	Female	Head of e-learning group
6	53	Male	Member of the Higher Council of Virtual Education
7	35	Male	Director of Education
8	57	Female	Educational vice
9	53	Male	Faculty member
10	52	Male	Director of Education
11	46	Female	Faculty member
12	50	Male	Faculty member

you think about this strategy?” and “What do you mean by that?”

The interviews lasted between 30 and 60 minutes. In each interview, the demographic data were collected, and subsequently, necessary explanations were given about the interview method and research objectives. Guba and Lincoln’s criteria were applied for trustworthiness.^[25]

Data analysis

Data collection and analysis were performed simultaneously. Granheim and Lundman’s approach to content analysis was used to analyze data.^[26] In the first step after each interview, the interviews were transcribed immediately. In the second step, the text of the interviews was read and reviewed several times to gain a general understanding. In the third step, the text of meaning was read word by word to extract the code. In the fourth step, the codes were categorized based on the intra-class similarities and how classes were related. Finally, data were divided into main categories and then the main theme was extracted.^[27]

Trustworthiness

Four criteria of credibility, confirmability, dependability, and transferability were used for trustworthiness. To assess credibility, the initial findings were reviewed by participants to check their opinions and feedback (member checking). Some parts of the findings were assessed by an expert not involved in the research. To determine dependability, the opinion of an external observer was sought. This external audit highlighted the consistency of the findings. To determine the confirmability of the results, all interviews were recorded. To make the results transferable, we attempted to transcribe the participants’ sentences verbatim.

Ethical consideration

This study was approved by the Research Ethics Committee of the School of Medical Education, Shahid Beheshti University of Medical Sciences in Iran (IR.SBMU.SME.REC.1400.026). Written informed consent from all participants was obtained. Also, participants were informed that their data would be ensured confidentiality and that they had the right to withdraw from the study at any stage without any consequences. In addition, all methods were done in agreement with relevant guidelines and regulations.

Results

Data from 174 codes were analyzed. The codes were classified into eight categories and one main theme [Table 2].

Principles of instructional design of mobile learning in medical education

Participants mentioned effective factors for designing and organizing mobile learning activities. This concept is characterized by pedagogical component, interactive design, effective and comprehensive analysis, achieving objectives with the mobile learning platform, generating micro- and interactive e-content, teaching-learning interactive methods, course implementation, and interactive evaluation at both micro- and macro-levels [Figure 1].

1- Pedagogical component

Participants believed that in mobile learning design, the learning theory should be decided from the beginning. Most participants believed that theories such as behaviorism, cognitivism, constructivism, connectivism, situational learning, cooperative learning, and lifelong learning should be considered in the design. One participant said (P2): “I think there are some learning theories that can support mobile learning, like constructivism that could be used by the learner to build new concepts based on his prior knowledge or situational learning that allows the student to learn in a real context.”

Another participant (P8) indicated: “Mobile learning is a form of cooperative learning that uses the ability to interact and communicate with the instructor and other students to complete tasks and activities for learning purposes. We may also call it a kind of informal learning that allows students to learn beyond the classroom at their own pace and preferences. The most important point is possibly connectivism theory; that is, learning occurs in a constantly changing environment, and it is better to say that the connection between databases (links) enables us to learn more.”

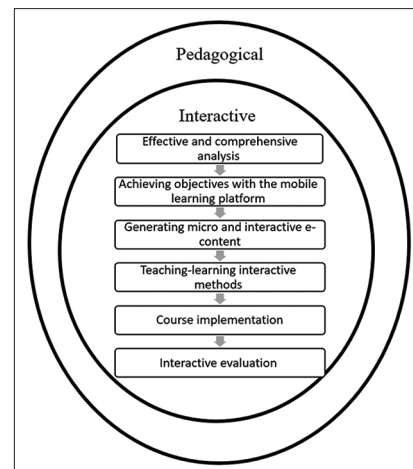


Figure 1: Eight main categories

Table 2: Theme, categories, and codes extracted from interview data

Theme	Categories	Codes
Principles of instructional design of mobile learning in medical education	1. Pedagogical component	1. Designing learning activities based on theories that support mobile learning
	2. Interactive design	1. Learner-learner interaction 2. Learner-teacher interaction 3. Learner-content-tool interaction 4. Teacher-content-tool interaction 5. Content-content interaction
	3. Effective and comprehensive analysis	1. Learners' analysis 2. Teachers' analysis 3. Context analysis
	4. Achieve objectives with the mobile learning platform	1. Determining cognitive, affective, and psychomotor objectives according to the available courses and facilities 2. Setting measurable objectives
	5. Generate micro- and interactive electronic content (e-content)	1. Preparing micro-e-content from simple to complex 2. Production of e-content based on Mayer's principles 3. Compatibility of content with different operating systems 4. Production of e-content in different formats (text, video, podcast) in accordance with the learning style of learners 5. Breaking long contents to micro-ones
	6. Teaching-learning interactive methods	1. Using group discussion approaches 2. Using problem-solving method 3. Case-based discussion 4. Using blended learning
	7. Course implementation	1. Acceptance of mobile learning courses in the curriculum 2. Pilot implementation of the course
	8. Interactive evaluation at both micro- and macro-levels	1. Using various methods to evaluate learners at the micro-level 2. More focus on formative evaluation 3. Macro-evaluation of the course through the attendance and involvement of students 4. Design of tests by gamification 5. Instant feedback to the learner 6. Individual and group evaluations

2- Interactive design

Most participants believed that learning occurred through the learner's interaction with various elements of the learning context and considered it as a stimulus for learning. They mentioned that this category should be considered at all stages of the instructional design.

They also stated that there should be an interaction between the learner-content-tool, teacher-learner, learner-learner, teacher-content-tool, and content-content.

About the interaction of content-tools, the teacher-learner, one participant (P3) stated: "When we say we have accepted the theory of constructivism, we determined more value to our interaction with each other. In mobile learning, we can gain these interactions through the design of forums, group assignments, or in teacher-learner interaction, the teacher can support the student by providing textbooks in the format of multimedia content or electronic resources. In addition, when the learner reads the contents, that knowledge

structure changes in his mind, which originates from the theory of cognitivism."

Another participant (P4) also mentioned the need for interaction between the teacher-content-tool and content-content: "Well, the interaction between the teacher-content is very important because it focuses on the role of the teacher in determining content and learning activities. It also allows the teacher to monitor and update content. On the other hand, interaction content-content, if you have designed a section in your application with relevant and up-to-date articles, this part of the application must get its data from another database, so these two parts of the content are interrelated, and you should pay attention to these interactions."

3- Effective and comprehensive analysis

Participants believed that using the learner, instructor, and context analysis may have enhanced mobile learning. They stated that in comprehensive analysis, attention should be paid to physical and mental learning styles as well as the desire to personalize learning. In the

analysis of the instructor, digital literacy and technology acceptance should be considered.

Participant 1 (P1) indicated: "We have to design the course based on the characteristics of the learners, including their age, gender, learning styles, and their desire to personalize learning." "In teacher analysis, digital literacy and technology acceptance must be considered."

Participant 6 (P6) also believed that context analysis in terms of infrastructure and relationships between learners is one of the important factors in comprehensive analysis and said: "First of all, in terms of content design, it completely depends on to what our audience has access to, that is, a context analysis. In my opinion, we need to analyze the context of our learners and the characterization, limitations, and advantages of the context. I do not mean environment, I am talking about context, it is important where the learner is, what level of learner, what factors influence the network, and what facilities and infrastructure."

4- Achieving objectives with the mobile learning platform

According to the participants, educational objectives should be based on Bloom's levels of taxonomy and appropriate to the learners' learning style and measurable. They believed that with the help of mobile learning, cognitive objectives can be easily achieved, especially attitudinal objectives.

In this regard, one participant (P7) explained: "In fact, with mobile learning, cognitive objectives, especially attitudes, can be achieved well, but we face limitations to achieve psychomotor objectives. In traditional education, we may achieve attitudinal objectives, but the effect is fleeting. And it may lose its effect after a week, but in mobile learning, it does not have the space and time limitations of traditional education, and it provides a situation where the effect of education is more lasting on learners' attitudes, and even if learners forget, they can see the content again."

Some participants announced that we face limitations in achieving psychomotor objectives in mobile learning. A participant (P5) described: "To achieve psychomotor objectives, we need simulation or virtual reality, which we cannot use due to budget constraints as well as the lack of facilities in our country."

5- Generate micro- and interactive e-content

Most participants referred to the production of electronic content in the form of micro-learning and the breaking

down of content into smaller items. A participant (P10) said in this regard: "In this way, the content should be designed short; that is, it should be micro. One of the differences between mobile learning and e-learning is that the content is shorter. It is interesting to tell you even recently, I saw the contents of one-minute video series embedded in educational applications."

Another participant (P9) stated on the interactive and diverse contents based on Mayer's principles: "On the other hand, our content should be interactive, which will increase the likelihood of the audience engaging with the content. For example, we can generate content with the help of a storyline and ask questions."

6- Teaching-learning interactive methods

Most participants emphasized that active teaching-learning methods such as problem-solving learning, case-based discussion, and group discussion should be used in mobile learning. A participant (P12) said: "Almost all active learning-education methods are useful here because they help the learner be engaged in the learning process more actively and lead him towards more engagement in learning and acquisition of knowledge. These include cooperative, problem-solving methods, role-playing, and, most importantly, group discussions. That is because all our teachers are more or less familiar with this method."

One participant (P11) said: "We have concluded that mobile learning is more effective when it is part of blended learning, especially in times of corona where virtual learning has become more common alongside face-to-face learning. It provides the conditions in which mobile learning can be better utilized."

7- Course implementation

Participants indicated that once the mobile learning strategy is accepted in the curriculum and the institution has made the necessary preparations; the course should first be tested in a pilot setting and then implemented extensively after any challenges are resolved. In this regard, one participant (P2) stated: "Well, after the curriculum embraced this type of strategy, now you should, first of all, run it as a pilot test to see the challenges at different stages. For example, your objectives or needs for assessments may be incorrect or you don't have the required technological infrastructure. All these challenges should be solved and then implemented on a large scale."

8- Interactive evaluation at both micro- and macro-levels

Evaluation is an integral part of any educational system. Evaluation should directly measure how objectives

defined for the course are achieved. Participants explained that evaluation should be performed at both micro- and macro-levels. From the participants' point of view, learners and teachers should be evaluated at micro-level; the overall curriculum should be evaluated at macro-level.

Participants suggested short survey designs after each course to evaluate the teachers. The learner assessment should be based on the objectives of the course and mostly formative. They suggested e-MCQ, scenario-based activities, and e-open book exam informative tests to measure cognitive objectives, online discussion/e-group to measure attitudinal objectives, and game and online role-play to measure psychomotor objectives. Some participants believed that electronic-patient management problem (e-PMP), electronic-multiple-choice question (e-MCQ), electronic-key feature problems (e-KFP), electronic-clinical reasoning problem (e-CRP) tests can only be used in summative assessment of cognitive objectives. In this regard, one participant (P3) stated: "We made an application to be linked to the Faradid system (online exam website in Iran) so that students could take the Faradid tests as the final exams using their smartphones."

For the evaluation at macro-level, participants stated that interviews with learners and teachers could be used. Also, for the effectiveness of the course, a semi-experimental method such as a pre-test-post-test design could be used.

Feedback plays an important role in mobile learning to motivate and encourage learners. A participant (P7) expressed the importance of immediate feedback in exams: "One of the important features of these courses is immediate feedback and we should try to consider this issue in designing our exams."

Discussion

The present study aimed at identifying and extracting the key principles for designing and implementing mobile learning in medical education in Iran from the perspective of experts in the area of mobile learning in medical school. The experiences of the participants in this study were gathered in an overall theme reflecting the principles of mobile learning design in medical education: Pedagogical component, interactive design, effective and comprehensive analysis, achieving objectives with the mobile learning platform, generating micro- and interactive e-content, teaching-learning interactive methods, course implementation, and interactive evaluation at both micro- and macro-levels.

To create better opportunities for mobile learning in medical education, instructional design is of particular

importance.^[28] One of the strengths of this study is the introduction of a new model of mobile learning instructional design. The participants noted factors for designing and organizing instructional activities in mobile learning and increasing their effectiveness.

The finding of this study indicated that in mobile learning, instructional design should be formulated interactively. Research reports that interaction helps students and faculty interact with each other in the context of mobile learning.^[29] Previous studies have shown that interaction enabled learners to collaborate, especially in fieldwork. It helped learners share information, participate in social networks and forums, download presentation slides and podcasts, get instant feedback from teachers, and receive alerts about deadlines.^[30]

A study on the effect of mobile learning implementation on medical and nursing education emphasized the importance of designing appropriate content.^[29] But knowledge is lacking student assessment methods in mobile learning models in medical education. In this study, participants stated that learner assessment should be based on the objectives of the course and mostly formative. In addition, they believed that cognitive, attitudinal, and psychomotor objectives can also be evaluated in a formative method, but in summative assessment, only cognitive objectives can be evaluated.

In his study, Ng stated that pedagogical components play an important role in mobile learning. Medical education specialists can ensure that learning occurs best in educational environments by designing it based on learning theories. Prior studies have shown that instructional design in the mobile learning system helps learners to learn independently, gives them the right to choose content and pay attention to their differences, use real-life examples using computer facilities, and provide timely feedback.^[31] These results are in line with the present study. Another study found that mobile learning led to interaction between teacher and learner without intermediaries, created motivation, and, as a result, better performance in exams.^[32]

In terms of the interactive aspect, Zamani stated that learners use mobile phones to interact with their peers and to transfer information and ideas to other learners.^[33]

In terms of micro- and interactive e-content as well as new evaluation methods, Shohel also stated that the students participate in the mobile learning process by sending a text message. As a result, their motivation in writing and sharing scientific points increased, and this caused the content to be reviewed and learning to be promoted. On the other hand, designing efficient and small software programs to be installed on mobile

phones can provide content to learners at any time and place. In such circumstances, the process of continuous learning and evaluation will be more circular.^[34]

One of the main elements affecting the influences of an instructional method is using an instructional design method appropriate for changing the teaching and learning environment. In the present article, using eight principles of mobile learning design in medical education, a dynamic and interactive educational setting was provided for medical students. Our study is in line with the results of Mofrads' research. They use Gagne instructional design meanwhile our design was based on experts' opinions.^[28]

Limitations and recommendation

Since some of the participants did not allow the recording of the conversations, the researcher was forced to write down everything he had heard and refer to the participant again to resolve ambiguities after reviewing the interview and analyzing it. Another important issue was that the researcher made several appointments to interview the deans and educational administrators, but the appointments were postponed several times due to the busy schedule of the teachers.

Future research can focus on the development of this educational design for different fields of medical sciences. We designed a qualitative study, so it is suggested to use the results of this qualitative study to design mobile learning interventions.

Conclusions

Given the significant effect of the COVID-19 pandemic on especially medical education, medical schools have certainly moved towards mobile learning to make up for the discontinuity in traditional education. Following the discovery of the principles of instructional design of this strategy, the results of interviews with key informants in this field showed that eight key principles are needed for mobile instructional design to improve the quality of education. These eight key principles include pedagogical component, interactive design, effective and comprehensive analysis, achieving objectives with the mobile learning platform, generating micro- and interactive e-content, teaching-learning interactive methods, course implementation, and interactive evaluation at both micro- and macro-levels.

The participants prioritized the pedagogical component and interactive design as the two most important principles.

To make mobile learning more effective in this pandemic, it is suggested that medical schools should provide

technical infrastructure such as (up-to-date educational software and suitable and free internet access) and educational infrastructure (specialized technical and educational faculty). Evaluation at both micro- and macro-levels after the implementation should be ensured and give appropriate feedback should be given to the educational program after evaluation.

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Conflicts of interest

There are no conflicts of interest.

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