Original Research Article

Development, Implementation and Evaluation of a Smartphone-Based Study Guide for Undergraduate Medical Students

ABSTRACT

Introduction:
Most medical educators agreed that e-Learning is a necessity nowadays and not a luxury shift. Smartphones contribute to the educational process to a great extent. Integrating the use of smartphones in the curriculum has an important innovative role in medical education and health care services. Currently, medical students are using smartphones as part of their daily routine and learning activities. A study guide is a tool designed to facilitate students' interaction with the various components of the curriculum. The idea of using a mobile application in providing information through a study guide to facilitate learning was reported by different studies.

Aims: The study aims at designing, implementing, and evaluating a smartphone-based study guide for two integrated modules for first-year medical students at the Faculty of Medicine, Suez Canal University (FOM-SCU) to enhance students' mobile learning (m-learning) experience.
Study design: This study is a quasi-experimental (pretest-posttest), using a non-probability convenience sampling, 105 students (response rate 84%), and 16 class tutors (response rate 100%).
Place and Duration of Study: Department of Medical Education, Faculty of Medicine Suez Canal University during the academic year 2017-2018.
Methodology: Using a non-probability convenience sampling, 105 students (response rate 84%), and 16 class tutors (response rate 100%).**Results:** Most of the students (94.3%) stated that smartphone is useful in Medical Education, 80.9% of them agreed that the module objectives can be met through m-learning and 61.9% of the students agreed on recommending m-learning as an innovative method of learning to others. The evaluation of students' performance in the context of PBL by their class tutors showed a statistically significant improvement in all items regarding the four factors assessed "independent study" (p-value <0.001), "group interaction" (p-value <0.001), "active participation" (p-value <0.001), and "reasoning skills" (p-value <0.001) when comparing pre and post-intervention scores.
Conclusion: This study concludes the m-learning has a positive effect on the students' performance in the PBL context. It is remarkably significant to integrate smartphone-based learning activities in the undergraduate Medical Education curriculum. Our results can encourage other health professions institutions to apply m-learning in different educational situations.

Keywords: M-learning, smartphones, mobile application, study guide, integrated module, PBL

1. INTRODUCTION

"Educational technology" is a term which covers the physical component of education (hardware) as well as the associated educational theories. As a result of the digital revolution in modern education, new terms and paradigms have emerged such as e-learning, multimedia learning, technology-enhanced learning (TEL), computer-based instruction/training (CBI/CBT), computer-aided instruction (CAI), internet-based training (IBT), web-based training (WBT), online education, simulation-based learning, computer-mediated communication, cyber-learning, networked learning, virtual learning environments (VLE), mobile learning (m-learning), blended learning, and digital education [1].

Currently, medical students are using mobile devices as a part of their daily routine. Access to these new technologies has become much easier and faster. According to surveys conducted in several universities, there are increasing numbers of students using a smartphone or a tablet in medical education [2,3]. Current smartphone apps for medical students include a variety of anatomy and dissection apps such as Gray's anatomy, Netter's anatomy flash cards, and Zollinger's atlas of surgical operations [4]. This type of education is called m-learning which is defined as "learning across multiple contexts, through social and content interactions, using personal electronic devices" [5].

One of the theoretical frames that explain m-learning is the activity theory developed by Engestrom in 1993. According to this theory, traditional medical education tends to place the teacher in the role of a subject (a person or group from whose viewpoint the activity is performed) and the student in the role of an object (a person or group that is the focus of the activity). However, a more innovative education places students as subjects engaging with a medical education program (object) to become a doctor (outcome) [6, 7].

Some opponents argue that m-learning can have disadvantages such as having technology problems [8], facing the risk of students' distraction [9], and breaking down barriers between personal vs. professional or educational mobile use [10]. Also, educators might become occupied by technology development and forget about the learning process [8]. However, many studies have proved that m-learning has more advantages including: mobility, portability [11], reasonable cost, and more situated and contextual learning [12]. It also enables learners to do other non-educational activities while learning [13], in addition to facilitating quick, easy, and continuous communication and interaction [14].

Moreover, m-learning is applicable in problem-based learning (PBL), where student-centred learning is based on authentic problems [15]. It allows students to imagine themselves in realistic situations requiring them to apply and develop their knowledge and problem-solving skills [16].

The term PBL is employed to transfer different concepts with different meanings. It is preferred to think of PBL as the active learning process that can be stimulated by a clinical scenario. The principal idea behind problem-based learning is that the starting point for learning should be a problem that learners need to solve. Students using adult leaning principles work on the problem to identify and search for the knowledge that they need to obtain in order to approach a solution [17]. In medical PBL curricula, problems are traditionally presented with the written description of clinical cases and supporting inquiry materials such as clinical data. More recently, multimedia such as video clips and images are employed in designing PBL problems. During PBL phases, students can use their mobile devices to connect to other sources of information on the internet, or even the other learners and the teacher [18]. They may search for the definitions of novel or unfamiliar terms in the

given medical scenario and other case-related information to understand the various dimensions of the problem at hand. Using mobile devices to access resources that are significant to the PBL discussion has been viewed as positive in facilitating collaborative knowledge and creating new educational experiences [15].

A study guide is a tool designed to facilitate students' interaction with the various components of the curriculum. It can help students to plan their learning along with the intended learning outcomes (ILOs), make the best use of the learning opportunities provided, choose appropriate learning strategies, prepare for the assessment procedures and respond appropriately to the educational environment of the institution [19]. Its value has increasingly been recognized with the greater emphasis now placed on student-centred learning [20].

In PBL modules, traditional study guides are used in print format, but in technological era, the electronic study guides are gaining their place as innovative learning tools in the educational setting where students explore medical case scenarios. Providing electronic study guides through mobile apps can be considered the easiest and the most effective learning tool. Also, the evidence shows that mobile devices have an ever-growing presence in medical education as its use is accessible by both teachers and students [21].

The Egyptian medical education system admission policy is managed by a national body office supervised by the Ministry of Higher Education. Students apply electronically through the office website then they are distributed on different higher education institutions according to the order of their preferences and their high school credentials. Till the year 2017, the Egyptian medical schools follow the French model with a 6-year bachelor program (MBBch) including 3 pre-clinical years followed by another 3 clinical years, then graduates must spend one year for the internship training to get the license to practice [22].

In the academic year 2018-2019, a newly-developed Egyptian undergraduate medical education curriculum named 5+2 by the Council of Ministers issued decree No. 565 of 2018 [23]. It amends the duration of study for the degree of Bachelor of Medicine and Surgery (MBBch) to become five years (2 preclinical + 3 clinical) on the basis of the credit hours system then graduates must spend two years of Internship clinical training ending by a medical licensing exam to get the license of practice.

One of the well-established Egyptian medical schools which utilize PBL strategy is The Faculty of Medicine- Suez Canal University (FOM-SCU). In 1978, it was established as the first medical school in the Middle East that adopts innovative educational strategies including integration, problem-based learning, and community oriented/based and student-centred education [22].

Till the start of this research no any evidences on literature showed the use of smartphone-based study guide in medical education and no official attempts were made by FOM-SCU to enter the world of mobile learning and to use this readily available technology that has become part of everyone's daily routine. Therefore, there was a need for preparing a study guide using a smartphone application to cope with the new era of educational technology innovation and gain the reported advantages of its application.

Therefore in this study we designed, implemented and evaluated a smartphone-based study guide for two integrated modules of the first year medical students at FOM-SCU. The aims of the study were to assess the students' needs of smartphone in learning, measure their satisfaction regarding the used guide based on mobile application, and evaluate their performance in PBL tutorial sessions (pre- and post-implementation of the

application). Our study research questions were first; Will FOM-SCU students perceive study guide mobile application as an effective component of their learning experience?, second; Is the designed and implemented smartphone-based study guide has an effect on the first year students' performance during PBL tutorial sessions.

2. METHODOLOGY

2.1 Study Context & description: This was a quasi-experimental (pretest-posttest) study, conducted from June 2017 to November 2019 at the FOM-SCU. The study consisted of five phases (the steps for each phase are explained in Figure 1):

- **Phase 1:** The study guide planning for certain modules of year 1 medical students including evaluation of the study guide content using Delphi technique.
- **Phase 2:** The communication architecture for the development and management of the learning activities of the mobile application.
- **Phase 3:** Pre-implementation: Needs assessment of participating students and Pre-test assessment of the performance of participating students in PBL tutorial sessions made by their tutors.
- **Phase 4:** Implementation of the smartphone based study guide.
- **Phase 5:** Post-implementation which includes evaluation of the study guide application by the students, the post-test assessment of the performance of participating students in PBL tutorial sessions by their tutors, and Focus group.

2.2 Sampling: The study used a non-probability convenience sampling technique. All first-year medical students for the academic year 2017-2018 at FOM-SCU (n=125) and all first year class tutors of the same year (n=16) were invited to participate in the study. There were 105 students (response rate 84%) and 16 class tutors participated in the study (response rate 100%).

2.3 Data Collection Methods: Mixed methods of quantitative and qualitative data collection were used in this study as follows:

2.3.1. Evaluation of the designed electronic study guide by medical education experts using the Delphi technique: The developed study guide contains many different sections such as; welcome message, the aim of study guide, academic advising committee, basic information about the module, intended learning outcomes of the module, the modules different learning activities with the learning outcomes for each session, learning resources, assessment methods with mark distribution, examination rules and regulations, students' responsibilities in different learning settings, and the module timetable. Open ended questions were sent to a panel of experts in the medical education department at FOM-SCU to assess the study guide content adaptation to the mobile application. A Delphi process consisted of two rounds. The first round responses were analysed by sorting, categorizing and searching for common themes. These responses were edited and then used to construct the second round which was sent to the experts again where a consensus was reached on the final designed and used guide.

2.3.2. Needs assessment of smartphone use in learning among the participating students: An "assessment of perception" questionnaire was distributed to 1st year medical students pre intervention, (the questionnaire was quoted from Robinson et al. (2013) study, which aiming at investigating the behaviour and attitude of medical students regarding the use of smartphone in their education. It is sixteen items designed to elicit: the proportion of students owning smartphones; how these devices were used for educational purposes; and the perceived advantages and disadvantages of introducing smartphones onto a medical

degree in future. The questionnaire is mostly quantitative, using four-point Likert scales in addition, three questions were open-ended, serving to describe and explain current behaviours and opinions in greater depth [24].

2.3.3. Evaluation of the effectiveness of the smartphone-based study guide application, by participating students, using two readymade questionnaires:

2.3.3.1. The first questionnaire was quoted from Georgieva et al. (2011) and aimed at evaluating the mobile application (Google classroom was used in this study) experience and perception of students toward the experience. It consisted of 25 items divided into four sections: technical feasibility, didactic efficiency, cost-effectiveness, and user-friendliness. All items were evaluated by a Likert 5-point scale. The users needed to provide their level of agreement/disagreement using the scale from 1 = strongly disagree to 5 = strongly agree [25].

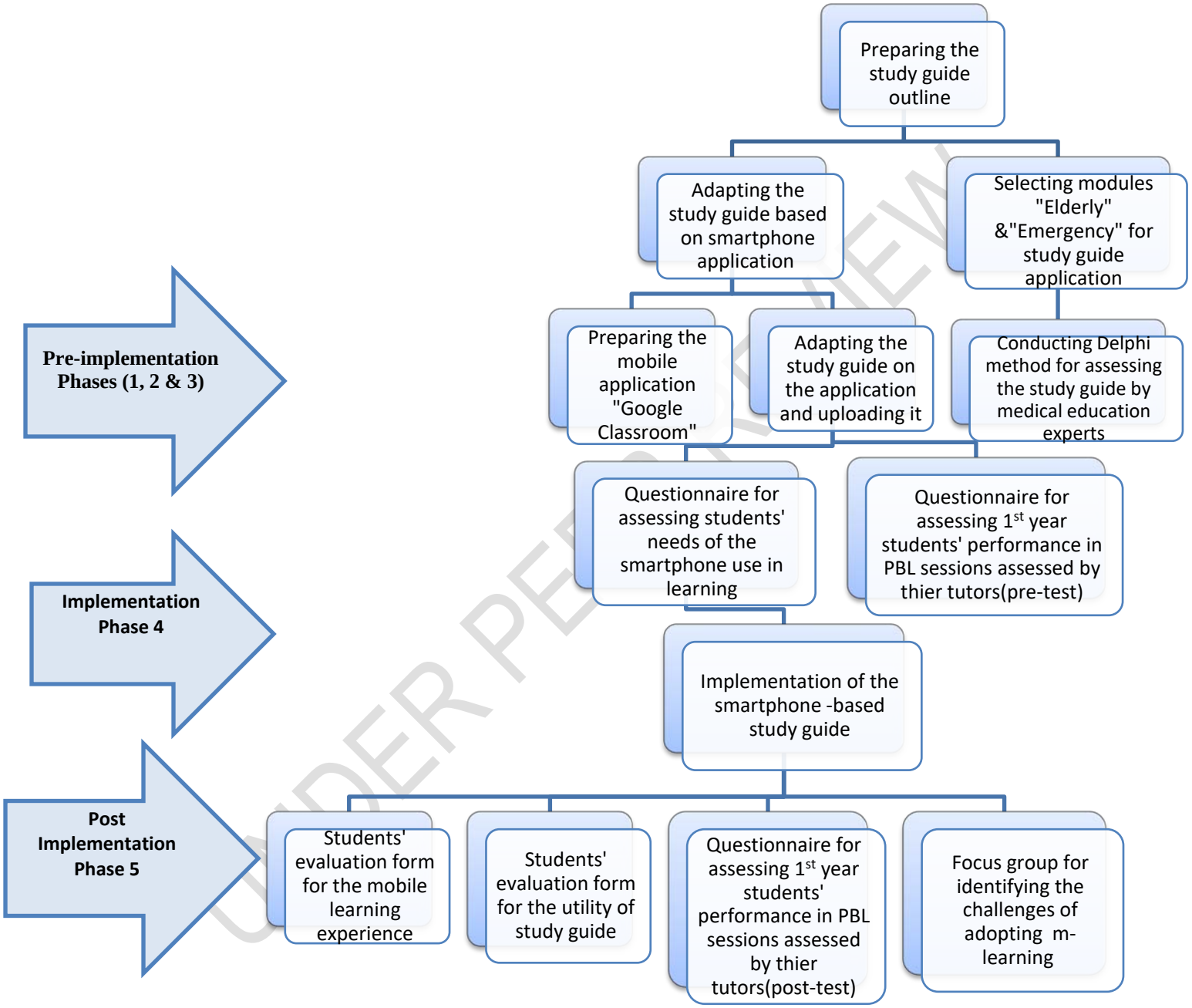
2.3.3.2. The second questionnaire was quoted from Babar, S. and Baig, L. (2014) which aimed at evaluating the students' perception of the study guide usability. It was consisted of two parts: the first section had demographic data, and the second section dealt with data of perception regarding the use of the study guide to aid learning. The second section consisted of 27 items divided into five themes: outlook, content, assessment, self-directed learning and information about resources. Each item was evaluated by a Likert 5-point scale, ranging from 1 to 5 indicating 1= strongly disagree and 5=strongly agree [26].

2.3.4 Evaluation of students' performance in PBL tutorial sessions (pre- and post-implementation of the smartphone-based study guide application): The used evaluation form was modified from Valle et al. (1999) and adapted to assess students' performance as a group during PBL tutorial sessions before and after using the smartphone-based study guide application. The tutor's evaluation form had 24 items that were based on a rating scale and distributed among four factors which reflected the essential components of PBL: independent study, group interaction, reasoning skills, and active participation. It assessed students' reaction to the PBL process and their level of motivation [27].

2.3.5 A focus group with first year medical students after the implementation of the smartphone-based study guide application. The aim of this focus was to identify the challenges of adopting mobile learning and how to overcome those challenges. The session was about 60 minutes. Qualitative analysis was described in terms of thematic analysis and responses divided into four themes.

2.4 Statistical Analysis: Data analysis was performed using the Statistical Package for the Social Sciences (SPSS version 21). According to the type of data, the following were used: a descriptive analysis by calculating the mean and frequency distributions, a paired t-test for comparing the four factors' means of the tutors' questionnaire (pre and post-implementation), and Wilcoxon signed-rank for testing the difference in categorical data. P-value was set at <0.05 for significant results.

Fig. 1: The Study Conceptual Framework



3. RESULTS AND DISCUSSION

3.1 RESULTS

Demographic analysis showed that 53% of the participating students were males (The total number of the participants was 105). All tutors of the 16 classes were included in the study to evaluate each group of students. Most of the participating tutors were from Physiology, Pathology, Pharmacology, Biochemistry and Medical Education departments.

Assessment of the designed study guide by Delphi technique was performed by a group of Medical Education experts. Out of 11 experts, 8 only responded (73%). Two rounds of Delphi were conducted based on semi-structured interviews and they included all the sections of the proposed study guide. The items that gained more than 90% agreements in the first round were deemed accepted and were not resubmitted in the second round.

Results showed that many items used in the Delphi technique such as the aim of the module, teaching & learning, schedule, problems and problems' exercises were all accepted in the first round. On the other hand, the other items such as cover page, welcome note, learning materials, and assessment were accepted after the second round with some modifications.

Most of the students (94.3%) stated that smartphone in Medical Education is useful (Figure 2), 80.9% of them agreed that the module learning objectives can be met through m-learning (Figure 3) and 61.9% of the students agreed on recommending m-learning as an innovative method of learning to others (Figure 4).

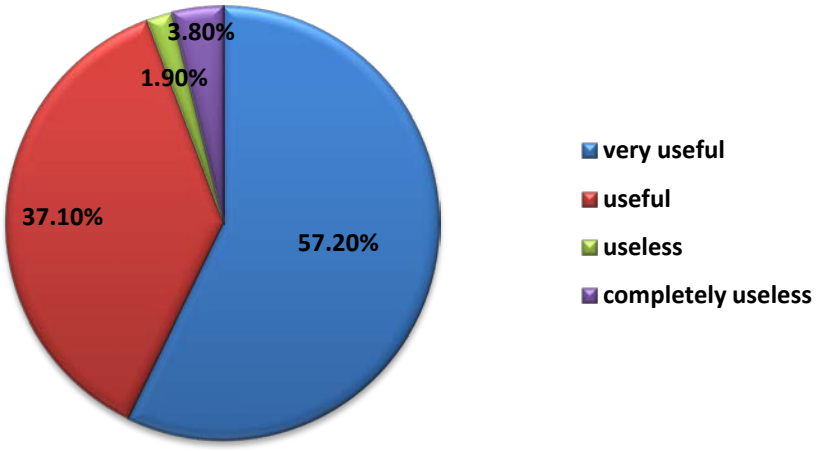


Fig. 2: Frequency Distribution of Participating Students' Perception Regarding How Useful a Smartphone in Medical Education (N=105)

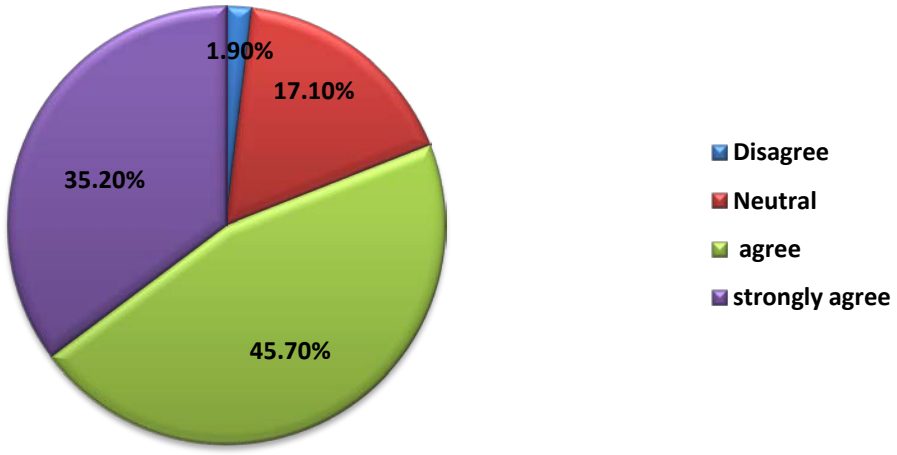


Fig. 3: Frequency Distribution of Participating Students' Opinion about Achieving the Module Learning Objectives by Mobile Learning (N=105)

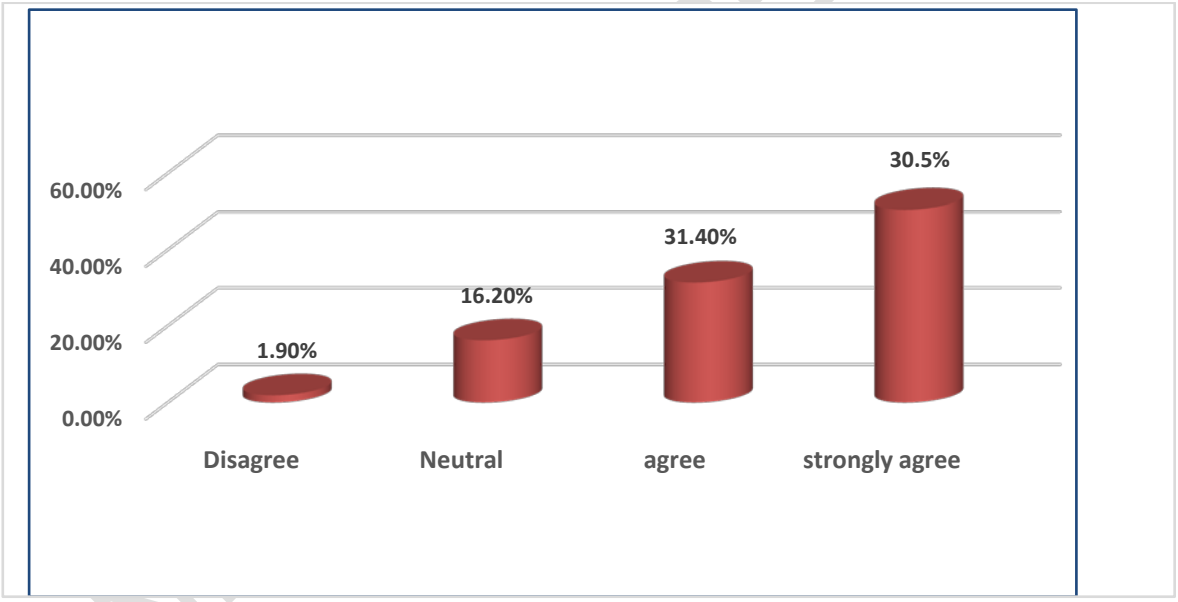


Fig. 4: Frequency Distribution of Participating Students' Opinion on Recommending m-Learning as a Learning Method to Others (N=105)

In terms of students' satisfaction regarding the technical feasibility of the smartphone-based study guide application, 68.5% of the students agreed that they always knew where they were in the module and 71% of them agreed that the module study guide application offered useful tools (help, resources, glossary, etc.) that supported learning (Table 1).

Table 1. Frequency Distribution of the Participating Students' Degree of Agreement Regarding the Technical Feasibility of the Smartphone-Based Study Guide Application (N=105)

Technical feasibility	Study group	
	No	%

The graphical user interface is well designed	Disagree Neutral Agree	7 31 67	6.7 29.5 63.9
Multilingual support is very useful.	Disagree Neutral Agree	13 14 78	12.4 13.3 74.3
Learners always know where they are in the module.	Disagree Neutral Agree	11 22 71	10.5 21.0 **68.5**
Fonts (style, colour, saturation) are easy to read).	Disagree Neutral Agree	10 8 87	9.6 7.6 82.8
The module application offers tools (help, resources, glossary, etc.) that support learning.	Disagree Neutral Agree	9 22 74	8.2 21 **70.8**
This mobile learning to be effective it is necessary to use graphics, illustrations, and sound.	Disagree Neutral Agree	7 11 87	6.7 10.5 82.9
Note: Results of strongly agree and agree combined.	**Total**	**105**	**100.0**

Many students (77%) expressed their satisfaction regarding the didactic efficiency of the application as they were able to communicate easily with their tutors in this module. Also, 76.2% of them agreed that the evaluation and questioning in the mobile learning module were effective (Table 2).

Table 2: Frequency Distribution of Students' Degree of Agreement Regarding Didactic Efficiency of the Smartphone-Based Study Guide Application (N=105)

Didactic efficiency		**Study group**	
		No	**%**
Mobile learning is convenient for communication with other module students.	Disagree Neutral Agree	13 15 77	12.4 14.3 73.4
Communication with the tutors was easy in this module.	Disagree Neutral Agree	2 22 81	1.9 21.0 **77.1**
Learners can start the module using only online assistance.	Disagree Neutral Agree	9 34 62	8.6 32.4 59
The module incorporates novel characteristics.	Disagree Neutral Agree	5 34 66	4.8 32.4 61.8
The module stimulates further inquiry.	Disagree Neutral Agree	6 19 80	5.7 18.1 76.1
The module is enjoyable and interesting.	Disagree Neutral Agree	6 21 78	5.7 20.0 74.3

The module provides the learner with frequent and variable learning activities that increase learning success.	Disagree Neutral Agree	0 28 77	0 26.7 73.3
Vocabulary and terminology used are appropriate for the learners.	Disagree Neutral Agree	14 18 73	13.3 17.1 69.5
Evaluation and questioning in the mobile learning module were effective.	Disagree Neutral Agree	6 19 80	5.7 18.1 **76.2**
Note: Results of strongly agree and agree combined.	**Total**	**105**	**100.0**

In terms of the students' satisfaction regarding the general outlook of the study guide, more than half of the students (59.1%) agreed that the outlook format helped them follow the instructions easily and 70.5% of them agreed that enough information was provided about self-directed learning (Table 3).

Table 3. Frequency Distribution of Students' Degree of Agreement Regarding the General Outlook of the Study Guide (N=105)

Items (outlook)		Study group	
		No	**%**
The information provided is logically organized	Disagree Neutral Agree	6 15 84	5.7 14.3 80.0
The format adopted help me follow the instruction easily	Disagree Neutral Agree	11 32 62	10.5 30.5 **59.1**
The given information about the tutors is enough.	Disagree Neutral Agree	6 12 87	5.7 11.4 82.9
The given knowledge about self-directed learning is sufficient.	Disagree Neutral Agree	13 18 74	12.4 17.1 **70.5**
The given knowledge about large group lectures is enough.	Disagree Neutral Agree	8 13 84	7.6 12.4 80.0
The given information about small group session is enough.	Disagree Neutral Agree	6 20 79	5.7 19.0 75.2
Note: Results of strongly agree and agree combined.	**Total**	**105**	**100.0**

Regarding the students' satisfaction with the content of the study guide, 73.3% agreed that the study guide covered the module content and 75.2% expressed that it effectively facilitated time management (Table 4).

Table 4. Frequency Distribution of Students' Degree of Agreement Regarding the Content of the Study Guide (N=105)

Items (content)	Study group	
	No	**%**

Helps in covering module content	Disagree Neutral Agree	7 21 77	6.7 20.0 **73.3**
Learning objectives help me to prioritize the important topics for learning	Disagree Neutral Agree	8 26 71	7.6 24.8 67.6
Identifies learning strategies for every objective beforehand	Disagree Neutral Agree	6 14 85	5.7 13.3 80.9
Indicates the duration of the module	Disagree Neutral Agree	14 24 67	13.3 22.9 63.8
Facilitates in managing time effectively	Disagree Neutral Agree	12 14 79	11.4 13.3 **75.2**
Note: Results of strongly agree and agree combined.	**Total**	**105**	**100.0**

Tutors' evaluation of the students' performance "as a group" in PBL tutorials (pre- and post-implementation of the smartphone-based study guide application) indicated that there was a statistically significant improvement in all assessed items, when pre and post intervention scores were compared regarding the "independent study" (Table5), "group interaction" (Table 6), "reasoning skills" (Table 7), and "active participation" (Table 8).

Table 5. Differences between Tutors' Pre-and Post- Evaluation Regarding Students' Independent Performance in PBL Sessions (n=16)

Items (Independent study)		Pre-intervention		Post-intervention		P-value
		No	%	No	%	
Students use different resources to obtain needed information.	Disagree Neutral Agree	0 8 8	0 50.0 50.0	0 0 16	0 0 100	**0.001***
Students use additional references to those suggested by the program.	Disagree Neutral Agree	6 3 7	37.5 18.8 43.8	0 6 10	0 37.5 62.5	**0.000****
Students present well-organized information relevant to the case.	Disagree Neutral Agree	0 6 10	0 37.5 62.5	0 4 12	0 25.0 75.0	**0.000****
Students are persistent in the study of the case.	Disagree Neutral Agree	4 6 6	25.0 37.5 37.6	0 2 14	0 12.5 87.5	**0.001***
Students are motivated to know more.	Disagree Neutral Agree	4 5 7	25.0 31.3 43.8	2 4 10	12.5 25.0 62.5	**0.001***
Students implement activities to achieve the learning objectives.	Disagree Neutral Agree	0 6 10	0 37.5 62.6	0 0 16	0 0 100	**0.001***

Students show initiative in the study of the case.	Disagree Neutral Agree	0 8 8	0 50.0 50.0	0 0 16	0 0 100	**0.000****
Students show initiative in the search of information.	Disagree Neutral Agree	4 6 6	25.0 37.5 37.5	0 2 14	0 12.5 87.5	**0.002***
Students accomplish tasks agreed by the group.	Disagree Neutral Agree	2 2 12	12.5 12.5 75.0	0 2 14	0 12.5 87.5	**0.005***
Total score # (Mean± SD)		**31.06±6.3**		**39.94±4.1**		**<0.001****

Wilcoxon test* #paired t-test significant p <0.05 ** Highly significant p <0.001

Table 6. Differences between Tutors' Pre- and Post- Evaluation Regarding Group Interaction among Students in PBL Sessions (N=16)

Items (Group Interaction)		**Pre-intervention**		**Post-intervention**		**P-value**
		No	**%**	**No**	**%**	
Students accept suggestions about their work.	Disagree Neutral Agree	4 2 10	25.0 12.5 62.5	0 4 12	0 25.0 75.0	**0.008***
Students adjust to different group roles	Disagree Neutral Agree	2 4 10	12.5 25.0 62.6	0 2 14	0 12.5 87.5	**0.008***
Students show respect to their peers.	Disagree Neutral Agree	0 2 14	0 12.5 87.5	0 0 16	0 0 100	**0.04***
Students accept decisions made by the group.	Disagree Neutral Agree	0 4 12	0 25.0 75.0	0 0 16	0 0 100	**0.005***
Students listen attentively to other members of the group.	Disagree Neutral Agree	0 4 12	0 25.0 75.0	0 0 16	0 0 100	**0.005***
Total score # (Mean± SD)		**19.19±3.4**		**21.88±1.8**		**<0.001***

Wilcoxon test* #paired t-test significant p <0.05 ** Highly significant p <0.001

Table 7. Differences between Tutors' Pre-and Post- Evaluation Regarding Students' Reasoning Skills in PBL Sessions (n=16)

Items (Reasoning Skills)		**Pre intervention**		**Post-intervention**		**P-value**
		No	**%**	**No**	**%**	
Students identify their learning needs.	Disagree Neutral Agree	0 7 9	0 43.8 56.2	0 0 16	0 0 100	**0.001***
Students ask questions related to the case.	Disagree Neutral Agree	0 6 10	0 37.5 62.3	0 0 16	0 0 100	**0.001***

Students accept or reject the hypothesis on well-based foundations.	Disagree Neutral Agree	2 4 10	12.5 25.0 62.5	0 0 16	0 0 100	**0.001***
Students analyze different components of the case.	Disagree Neutral Agree	2 5 9	12.5 31.3 56.2	0 2 14	0 12.5 87.5	**0.001***
Students Clarify facts, concepts, and terminology.	Disagree Neutral Agree	0 8 8	0 50.0 50.0	0 0 16	0 0 100	**0.001***
Students identify information relevant to the case.	Disagree Neutral Agree	2 5 9	12.5 31.3 56.2	0 0 16	0 0 100	**0.000****
Total score # (Mean± SD)		**21.56±3.5**		**27.88±1.7**		**<0.001****

Wilcoxon test* #paired t-test significant p <0.05 ** Highly significant p <0.001

Table 8. Differences between Tutors' Pre-and Post- Evaluation Regarding Students' Active Participation in PBL Sessions (n=16)

Items (Active Participation)		**Pre-intervention**		**Post-intervention**		**P-value**
		No	**%**	**No**	**%**	
Students give feedback (reflections, ideas, and suggestions) to the group.	Disagree Neutral Agree	4 8 4	25.0 50.0 25.0	0 3 13	0 18.8 81.2	**0.001***
Students help their peers to clarify ideas.	Disagree Neutral Agree	0 4 12	0 25.0 75.0	0 0 16	0 0 100	**0.005***
Students participate in case discussions.	Disagree Neutral Agree	0 6 10	0 37.5 62.5	0 0 16	0 0 100	**0.000****
Students share knowledge with the group.	Disagree Neutral Agree	0 4 12	0 25.0 75.0	0 4 12	0 25.0 75.0	**0.001***
Total score # (Mean± SD)		**14.31±1.96**		**18.13±1.03**		**<0.001****

Wilcoxon test* #paired t-test significant p <0.05 ** Highly significant p <0.001

Qualitative analysis of the focus group after the implementation of the smartphone-based study guide application. Based on thematic analysis, four themes with their subthemes were discussed with the first year medical students who responded to the focus group invitation as shown in (Table 9).

Table 9. Themes and Subthemes of the Focus Group with the Participating Students Regarding Challenges of Implementing Mobile Learning.

Themes	**Subthemes**
Challenges of implementing mobile learning at our school	**1. Resources** **2. Administration support** **3. Internet availability problems** **4. Cost** **5. Technical issues**

	"I don't believe that there is enough resources for such an expensive application or maintenance" *"Some students may struggle with the use of complicated applications"* *"There is no IT team to support such a project"* *"Internet connection is weak at the University"* *"University network doesn't cover the whole area properly"* *"Some of our colleagues are not from outside the collage city and have to stay at the dorm where there is no good internet connection"* *"Some technical errors will be a problem"* *"This is need financial resources"*
Areas of improvement for the implemented smartphone-based study guide application	**1. The design of the application** **2. The communication of the tutors** **3. Administration support** *"It was good but can be designed to be more easy and user friendly"* *"It was a Google classroom so it is good but a specially designed application would be better"* *"Tutors was involved but to a little extent, if they can communicate more it will be good"* *"Timing of posting the problems and weekly schedule were a little behind"* *"Administration used other channels to communicate with us so it was confusing at first"*
How to overcome those challenges?	*"The school should provide us with well-structured application that aids learning"* *"The administration should support the mobile learning and be an essential part of the educational process"* *"They should provide us with good internet connection all over the university"* *"If they provide us with tablets for learning it will be useful"* *"Get feedback from students about their needs"*
Examples of ideas that can be introduced as mobile learning	*"We need applications with all the data base we study"* *"We need access to some paid applications"* *"We need our own Atlas based application for Histology, Pathology and Parasitology slides"* *"We need more videos of lectures and labs"* *"We could use one of the simulation applications"* *"I think an application for the skills lab will be good"* *"The mentorship program can be applied through mobile application"*

3.2 Discussion

A study guide represents a method of interaction between the student and the course as it provides supportive information that can make a major contribution to learning. It can be thought of as a manual that structures study efforts and enhances the learning derived from textbooks [28].

The adoption of new technologies in developing a study guide at medical schools is a reality today. The evidence shows that smartphones and tablets have an ever-growing presence in undergraduates' medical education [21]. They can now provide an unlimited amount of information that is accessible anytime and anyplace. Therefore, m-learning can be considered as an easy, fast, interactive and innovative learning method [29].

Although research on m-learning has been extensively reported internationally, there is scarcely reported use of m-learning applications/courses in the health professions curricula of the Egyptian Universities. This research work is considered as one of the early trials to introduce the m-learning strategy through a smartphone-based application for undergraduate medical students. We designed and implemented a study guide for two integrated modules, for the first-year medical students at FOM-SCU, using the mobile application. The students' performance was evaluated by their tutors during PBL tutorial sessions before and after the implementation of the smartphone-based study guide.

This research work evaluated the students' perception regarding the mobile-based study guide application (Google classroom) using a questionnaire quoted from the study of Georgieva et al., (2011) [25]. Regarding the evaluation of "technical feasibility" of the application, the current study reveals that the majority of the students agreed that the module application offered useful tools (help, resources, glossary, etc.) that supported learning. In addition, more than half of the students agreed that the graphical user interface was well designed. These findings are in accordance with the findings of Georgieva et al. (2011) who evaluated a mobile learning system using mobile devices and they found that the greatest approval among consumers was about the fact that the graphical user interface was well designed [25]. Our findings are also consistent with the Chase et al. (2018) study which was conducted in the UK. In their study, the students were provided with m-learning devices (iPad mini) to support their placement-based learning [30]. Their results showed that m-learning most notably helped with the ability to link different sources of information, access to more up-to-date resources, access to multimedia learning and easier and faster information finding.

As for the evaluation of "didactic efficiency" of the application, the current study reveals that most students agreed that communication with the tutors was easy during the module, and most of the students agreed that mobile learning is convenient for communication with other module students. These findings can be explained by the user-friendly nature of Google classroom application that was used in this study and the fact that it allows easy interaction, communication, and chatting between participants. These results are consistent with a study conducted by Jin et al. (2017) in China where, the experiment group received the content via mobile application of webchat and there was a significant difference between the experiment group and the control group regarding the gaining of more opportunities to communicate with peers [31].

The result of evaluating "user-friendliness" of the application in our study indicates that most students agreed that they would take another mobile learning module if it is relevant to their learning needs. Most of them agreed that they would recommend m-learning as a method of learning to others. These findings can be explained by the fact that using m-learning as a teaching method is appealing to students because mobile devices became an everyday tool. These findings are concurrent with the results of the Georgieva et al. (2011) who found great agreement among their research participants on taking another m-learning course that meet their needs [25]. The current study results are also consistent with a study conducted in the Czech Republic by Klimova, (2019) where participants received a foreign language course based on m-learning and 80% of them agreed on implementing such a mobile app in other courses [32].

Consensus by the panel of Medical Education experts on the used study guide content in this research was reached in two rounds of Delphi technique. Our study guide was similar to the study

guide template developed by Al-Hazimi, (2012) in King Abdul-Aziz University in Jeddah, Saudi Arabia in terms of organization and sections such as: cover, list of content, aims, intended learning outcomes (ILOs), topics, assessment methods, and timetables [33].

The current study results about the outlook of the guide reveals that more than half of the students agreed that the format adopted helped them follow the instructions easily, and many of them believed that enough information was provided about self-directed learning. Those results are consistent with the findings of Babar and Baig (2014) study which revealed that most of the respondents (66%) stated that its organization helped them to follow instructions easily and many of them agreed that useful information was given about self-directed learning (60.7%) and PBL (59.5%) [26]. Also, the study of Ravichandran (2014), conducted in India, revealed that the included information in the students' study guide promoted self-directed learning [34].

The current study also showed that the students agreed that the simple layout of the study guide was student-friendly, and the information given about PBL was useful. These findings are attributable to the easy and clear format of the developed guide, the simple layout that is appropriate for first-year students, and the fact that important terminologies, goals, objectives, information about self-learning and details on PBL process were included in the guide. These results are also consistent with the findings of Babar and Baig (2014) study which revealed that the highest 'agree' response (74%) was given for the user-friendless of the guide layout [26].

In the current study the majority of students agreed that the study guide covered the content of the modules, facilitated time management provided a substantial guideline for the module, and that the objectives helped them identify the depth of the content to be learned. These findings are in agreement with the study of Ravichandran (2014) which showed the students' agreement (99.5%) about the well-organization of the study guide and coverage for the overall objectives of the modules. In addition, 85.6% of them believed that the teaching schedule mentioned in the study guide reflected proper planning and sequencing [34].

The last questionnaire was adopted and modified from the study of Valle et al., (1999) which was conducted in Mexico. It was used in this study to assess the students' performance by their tutors during tutorial sessions of PBL. Four factors reflecting essential components of PBL were included in the questionnaire: independent study, group interaction, reasoning skills, and active participation [27]. The current study showed that there was a statistically significant improvement in all assessed items of the four factors when comparing pre and post-intervention scores. All the PBL tutors asserted the positive effects of the study guide application on students' performance and attitude.

These findings can be explained by the fact that the guide provided students with a framework that assisted them to manage their curriculum content, acquire appropriate study skills and deal with important aspects in their study such as PBL small group discussion, integration, and self-directed learning. The use of study guide was especially valuable for the study participants as they are making efforts as first-year students to be familiar with the innovative learning approaches at FOM SCU. In addition, we believe that this delivered guide may helped them in organizing their study, interacting more with peers and tutors and yielding improvement in areas such as active participation, independent learning, and group interaction, which were all measured in the context of PBL tutorial sessions.

Contrary to this study findings, the study of Jin et al. (2017) which evaluated the effects of m-learning on academic performance and learning attitude in college classrooms. In their study, the empirical evidence rejected the notion that m-learning can result in better academic performance as no significant difference was found in the students' test results. This inconsistency may be explained by the fact that in their study there was an insufficient interaction and communication among the instructors, their colleagues and students which might have affected their findings [31].

However, our research work findings are strongly correlated with another study performed by Ismail et al. (2018) in Malaysia [35]. They focused on the way the PBL environment was integrated into the design process of mobile apps for learning scientific terms. They evaluated the effects of the mobile app on their students' critical thinking skills and found an improvement in the critical thinking performance in the post-test that was given eight weeks after using the mobile app [35]. This supports our results which showed that using the smartphone-based study guide for the integrated modules led to improvement of the first-year medical students' performance during the PBL tutorials

4. CONCLUSION

This study concludes that there is a need to integrate smartphone learning activities in the undergraduate Medical Education curriculum at FOM-SCU. Also, it proves that first-year students perceived the smartphone-based study guide as an effective component of their learning experience. In addition, the PBL tutors emphasized that the performance of the students during the PBL sessions significantly improved after implementing the smartphone-based study guide. These results can encourage other health profession institutes to apply m- learning in different learning activities.

Limitations of the Study:

Some limitations should be acknowledged, especially that overcoming them could lead to better findings. Using a bigger sample-size and applying this research work in more than one health professions institutions would help with establishing the generalizability of the results.]

ETHICAL APPROVAL

Ethical clearance for the study was obtained from the FOM-SCU Research and Ethics Committee and the written approval for the research work was obtained from the faculty administration. The participants' informed consent was obtained before implementing the study; Tutors and students were informed about study aims, were kept updated about any changes in the research, and were notified about their rights to refuse participating. Ethical conduct was maintained during data collection and throughout the research process. The confidentiality of the participants was maintained as the questionnaire was provided anonymously.

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