Effects on Saudi Female Student Learning Experiences in a Programming Subject Using Mobile Devices: An Empirical Study

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Abstract—There is a dearth of research on how mobile learning (m-learning) could help Saudi female students perform better in computer programming courses. This paper measures the educational experiences of Saudi female students using an empirical study based on a framework for m-learning in a computer programming subject. The empirical study sample was 21 female students who used the ViLLE software tool in their quizzes in a programming class. This study used a quantitative survey, including some open-ended questions, to collect data. The study results showed that students were satisfied with their m-learning experience. The degree of satisfaction demonstrates how mobile devices can enhance learning in a computer programming subject.

Keywords—programming, mobile learning, learning experience, Saudi Arabia

1 Introduction

Traditional teaching methods, such as taking notes on paper, are used by Saudi female computer science students. These methods are less engaging than learning with technology. In contrast, Saudi male students are permitted to use gadgets like computers and mobile phones, allowing greater interactions and better comprehension of the material [1]. This has led to a digital divide in computer science between the two genders [2]. Papadakis [3] emphasises that sexism in education can be reduced with proper teaching methods.

To encourage better classroom setups, Saudi Arabian institutions have recently started permitting female students to bring their devices to class[1] to make learning topics like computer science and programming more fascinating and engaging for them. As the vast majority of Saudis own mobile devices, mobile-based learning and teaching methodologies have become easier to use [4], [5]. Since both lecturers and students can access these tools for better communication, integrative strategies are used in colleges where women

[1] https://english.pravda.ru/news/world/138816-saudiwomen/

predominate, supporting a hands-on approach to improve learning comprehension [6]. Many studies [7], [8], [47] have demonstrated the various benefits of mobile learning (m-learning) in computer programming. Female-only universities in Saudi Arabia must adopt cutting-edge teaching and learning strategies, such as m-learning. No studies have been published on Saudi female computer programming students' exposure to m-learning. Thus, this study is guided by the following question:

- Has the proposed evaluation framework, Mobile Learning for Computer Programming (MoLeCoP), helped to improve female student performance in computer programming subjects by the end of the semester?

The primary objective of this paper is to assess the learning experience of students in the treatment group and evaluate the adoption of the MoLeCoP framework on the degree of satisfaction among Saudi female programming students. The remaining sections in the paper provide a literature review, the proposed theoretical framework, the study method, the results and a discussion.

2 Literature review

The influence of a program, a conversation or any other activity that involves learning is often referred to as a 'learning experience'. Most experts agree that non-traditional teaching and learning approaches, including mobile education, can improve understanding because they put the learner, rather than the teacher, at the centre of the process.

Mobile learning using mobile devices, known as m-learning, has been discovered to be more dynamic and interactive than traditional methods. Students can use applications, games and software to follow their instructors. A study by Levin and colleagues at Long Field Academy at the University of California showed that mobile device use in educational settings is advantageous [42]. The respondents recognised the advantages of m-learning and its impact on their teamwork.

3 Proposed theoretical framework

3.1 The MoLeCoP framework

M-learning and its related tools have been integrated into teaching and learning processes all around the world. With an emphasis on student involvement in the curriculum, active student participation in lectures and the addition of variety to the learning and teaching environment, the m-learning approach has evolved as an interactive interface in digital teaching methods and is adapted to millennial needs [10]. The MoLeCoP framework suggests that researchers investigate the following four aspects of computer-based learning environments:

- Promoting engagement in the learning system
- Enhancing students' learning experience

- Making perceived usefulness (PU) positive
- Understanding learners' behaviour.

3.2 Aspects of the MoLeCoP framework

This study used the four-factor MoLeCoP framework to pinpoint the factors influencing students' use of mobile devices during lectures for programming classes. The characteristics of each factor and how they relate to students' use of mobile devices to study more effectively are as follows:

Promoting engagement in a learning system (based on attitude towards computer use). The views of teachers on promoting the use of m-learning have had a significant impact on how much students are using technology [11]. Student engagement is the process that encourages students to take part in their education and values intellectual attitudes [12], [13]. This factor is related to students' satisfaction and attitude toward m-learning and whether that attitude is positive or negative.

According to Graham et al. [14], the significance of improving student learning through involvement is not new. The degree of student engagement has been proven to impact the success of the learning process, as well as student retention in schools or program enrolment [14]. As a result, active participation in the learning process is one of the crucial factors in students' academic performance [48].

Enhancing students' learning experience (based on the constructivism of seven principles). According to Chickering and Gamson [15], the constructivism attribute and the seven principles of effective learning for mobile-based education align with the learning process embracing m-learning. Most teachers think that teamwork feedback is an essential factor.

Mobile devices make it possible to receive immediate feedback. M-learning facilitates feedback, assisting students in completing their assignments. Programming education tools may provide feedback in the form of correct and incorrect responses, points or extrinsic rewards (such as animation, sound effects and increased power) [16]. Students exert more effort and perform better when they can track their progress toward their intended goals. M-learning is very helpful in large classrooms because it enables teachers to communicate with students by delivering messages about the course they are teaching, even when they are doing so from a distance [17].

Making perceived usefulness positive (based on Technology Acceptance Model). The technology acceptance model developed and theorised the notion of perceived usefulness as an essential element for students adopting information communication technology. Perceived usefulness complements the variables that influence how technology is used in situations that can be examined in terms of intents and behaviour, lending support to the rationale for this theory. Most studies on m-learning assume that people will use perceived usefulness-aligned technologies [18].

Student perception is that the use of mobile devices enhances learning [19]. For instance, students can learn indoors or outdoors and quickly access all the information they need, whenever they need it, wherever they are and without limitations [20].

Mobile devices used in programming classrooms is believed to improve student learning, boost student motivation and make it easier for teachers to foster and develop students' fundamental skills [13], [21], [22]. M-learning makes learning basic functions easier and helps students accurately understand programming principles [21]. Computer programming has become more engaging and accessible for teachers and students as m-learning has emerged as an effective tool.

Helping to understand learner behaviour (based on Saudi social norms). Since cultural attitudes and values impact how people use technology, this study investigates how cultural factors affect Saudi Arabian women who want to use m-learning to study computer programming [23] [24]. In Saudi Arabia, the nation's culture and norms present several obstacles for women to overcome before they can participate in and gain access to the field of programming.

Culture impacts people's attitudes toward technology since it shapes how they view modernisation [24]. Before introducing any new technology into a country or region, it is essential to acquire knowledge beforehand about the target population's culture-specific behaviours [25]. If there is a prior understanding of that country's culture, new technology can be adapted to fit that nation's customs. This way, cultural obstacles that could prevent people from adopting new technologies can be removed, or at least minimised.

3.3 Summary

This section explained how m-learning and teaching methods have been acknowledged as a more adaptable and practical approach to higher learning, which may be used successfully in contexts where women are taking computer programming courses. Student retention and success are both thought to be significantly influenced by student involvement. This study assesses the degree of satisfaction toward the MoLeCoP approach, which could provide a clear indication of how m-learning can enhance the process of learning.

4 Method

The study was conducted at Saudi Arabia's Aljouf University's computer science and information technology school, where the infrastructure did not support the use of mobile devices and where laptops were not required in lectures. The study concentrated on female students taking introductory Java programming courses. There were a total of 42 students enrolled for the first semester of the 2021 academic year.

4.1 Population and sample

The treatment group used a mobile-based learning approach using laptop computers with ViLLE visualisation software during in-class quizzes. To determine the sample size when the population size is known, the Krejcie and Morgan sampling method [26] was used. The 42 students were randomly divided into two groups of 21 each. The treatment group used the mobile-enabled ViLLE visualisation software application as the learning technique, while the traditional group used the conventional learning approach. In this study, we focus on the treatment group only.

4.2 Procedure

A survey with two sections was used to evaluate the validity of the students' learning experience in computer programming. The first section collected quantitative data on seven questions using a five-point Likert scale. The survey questions were pertinent to Saudi Arabia, where the study was conducted. The second section contained two qualitative open-ended questions that asked students to explain their performance and their likes and dislikes of using laptops for quizzes. Open-ended questions were used to elicit thorough responses [27], [28].

Online survey software called RedCap was used for the electronic distribution and collection of questionnaires and students' consent. Ethical approval was obtained before conducting the study from the University Human Ethics Committee (UHEC) of La Trobe University (Phone: +61 3 9479 1443, E: humanethics@latrobe.edu.au Approval number: HEC19520). The students were not at risk from this study. Before starting the surveys, students were informed about the study being conducted. After giving their consent, students received the survey and took about 10 to 15 minutes to complete it.

4.3 Survey instrument

The survey had seven items from previous studies, and two qualitative questions. Three of the survey's items were from Alghtani [29], three from Sawaan [30], and one each from Alzamil [31] and Alarfaj [32]. Table 1 lists the items and the source.

Table 1. Survey items and sources

Survey Item	Source
1. M-learning in computer programming eases the process of quizzes.	Sawaan [32]
2. M-learning in computer programming encourages me to learn more.	Algahtani [31]
3. My results in M-learning in computer programming were better compared to those I received in traditional learning.	Alarfaj [7]; Alzamil [34]
4. M-learning in computer programming met my needs.	Algahtani [31]
5. M-learning in computer programming met my expectations.	Algahtani [31]
6. M-learning in computer programming has increased my confidence.	Sawaan [32]
7. I want to take other courses using m-learning.	Sawaan [32]

5 Data analysis

To assess the adoption of the MoLeCoP framework, this study examined the educational experiences of the treatment group's students. All students in the treatment group were targeted for the survey. This stage of data analysis involves analysing the quantitative and qualitative survey data and determining the treatment group's satisfaction with the experience. SPSS Version 27 was used to analyse the quantitative data. The qualitative responses were transcribed into QSR NVivo 12 Plus data management program to identify the students' satisfaction with m-learning.

The demographic data of the students was gathered at the beginning of the first term, including their age, laptop ownership status, readiness to bring their computers to school and programming skills. These profiles are summarised in Table 2.

Table 2. Summary of demographics of treatment group

		Treatment Group
N		21
Age	19	66.7%
	18-20-21	33.3%
Laptop ownership	No	42.9%
	Willing to buy	-
	Yes	57.1%
Willing to bring laptop to university	Never	71.4%
	Occasionally	28.6%
Programming skill	Intermediate	14.3%
	Novice	85.7%

In the treatment group, the average student age was 19. Over half the students (57.1%) had laptops, but 71.4% of students never or rarely bring laptops to class. Most students (85.7%) rated their programming ability as novice, while 14.3% rated themselves as intermediate.

5.1 Reliability test

Cronbach's alpha was used to calculate and analyse the seven items. Cronbach's alpha ranges from r = 0 to 1, with r = 0.7 or above considered adequately reliable [33]. All items had a high correlation with item totals ranging from 0.608 to 0.817. Table 3 summarises the reliability and correlation results.

Table 3. Reliability and item-total statistics

	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Cronbach's Alpha if Item Deleted
1. M-learning in computer programming eases the process of quizzes.	23.0952	10.090	.735	.868
2. M-learning in computer programming encourages me to learn more.	23.3810	10.348	.656	.877
3. My results in M-learning in computer programming were better compared to those I received in traditional learning.	23.0952	10.190	.817	.859
4. M-learning in computer programming met my needs.	23.3333	10.233	.707	.871

	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Cronbach's Alpha if Item Deleted
5. M-learning in computer programming met my expectations.	23.3810	10.848	.620	.881
6. M-learning in computer programming has increased my confidence.	23.3810	10.648	.673	.875
7. I want to take other courses using M-learning.	22.9048	10.390	.608	.884

5.2 Results of learning experience in computer programming

The mean and standard deviation (SD) were used to describe the students' responses statistically. A five-point Likert scale was used for all the questions, ranging from 1 for 'strongly disagree' to 5 for 'strongly agree'. The five-point Likert scale's equivalent interval length is 0.80. When the mean score is 1–2.60, 'strongly disagree' and 'disagree' responses are at a low level; mean scores of 1–2.60 and 2.60–3.40 indicate a moderate agreement level, while a mean score of 3.40–5 indicates 'strongly agree' and 'agree' [34].

According to Table 4, all items had a high level of agreement with a mean score over 3.40, and none of the items received a 'strongly disagree' or 'disagree' answer. The overall m-learning mean score was 3.87 with a SD of 0.532, indicating that students had a high level of m-learning experience. The item 'I want to take other courses using m-learning' had the highest level of agreement, with a mean score of 4.19 (SD 0.750), while the item 'M-learning in computer programming encourages me to learn more' had the lowest level of agreement, with a mean score of 3.71 (SD 0.717).

Table 4. Descriptive statistics for participants' responses

	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree	Mean	Std. Deviation	Level	Rank
1. M-learning in computer programming eases the process of quizzes.	-	-	5	11	5	4.00	0.707	High	3
	-	-	23.8	52.4	23.8				
2. M-learning in computer programming encourages me to learn more.	-	-	9	9	3	3.71	0.717	High	6
	-	-	42.9	42.9	14.3				
3. My results in M-learning in computer programming were better compared to those I received in traditional learning.	-	-	4	13	4	4.00	0.632	High	2
	-	-	19.0	61.9	19.0				
4. M-learning in computer programming met my needs.	-	-	8	10	3	3.76	0.700	High	4
	-	-	38.1	47.6	14.3				
5. M-learning in computer programming met my expectations.	-	-	8	11	2	3.71	0.644	High	5
	-	-	38.1	52.4	9.5				
6. M-learning in computer programming has increased my confidence.	-	-	8	11	2	3.71	0.644	High	5
	-	-	38.1	52.4	9.5				
7. I want to take other courses using M-learning.	-	-	4	9	8	4.19	0.750	High	1
	-	-	19.0	42.9	38.1				
Overall experience of M-learning						3.87	0.532	High	-

5.3 One-sample T-Test results

The following hypothesis (one-tail test) was tested using a one-sample t-test to confirm whether the proposed framework was beneficial in enhancing students' m-learning experiences:

- H_0 Overall mean score of m-learning = 3.40.
- H_α Overall mean score of m-learning > 3.40.

A one-sided significant difference ($P < 0.05$) was found in the one-sample t-test results, suggesting that the null hypothesis H0 was rejected and that the overall mean score of m-learning > 3.40 denotes a high level of agreement. Additionally, Cohen's d [35] was used to determine the size of the effect of the framework. The effect size is described by Cohen [35] as small at d = 0.2, medium at d = 0.5 and large at d = 0.8 or more (see Table 5).

Table 5. One-sample t-test results

	Test Value = 3.40							
	t	Df	Significance		Mean Difference	95% Confidence Interval of the Difference		
			One-Sided p	*Two-Sided p*		*Lower*	*Upper*	*Cohen's d*
1. M-learning in computer programming eases the process of quizzes.	3.888	20	<.001	<.001	.60000	.2781	.9219	.70711 (medium)
2. M-learning in computer programming encourages me to learn more.	2.008	20	.029	.058	.31429	-.0122	.6407	.71714 (medium)
3. My results in M-learning in computer programming were better compared to those I received in traditional learning.	4.347	20	<.001	<.001	.60000	.3121	.8879	.63246 (medium)
4. M-learning in computer programming met my needs.	2.368	20	.014	.028	.36190	.0431	.6807	.70034 (medium)
5. M-learning in computer programming met my expectations.	2.238	20	.018	.037	.31429	.0213	.6073	.64365 (medium)
6. M-learning in computer programming has increased my confidence.	2.238	20	.018	.037	.31429	.0213	.6073	.64365 (medium)
7. I want to take other courses using M-learning.	4.832	20	<.001	<.001	.79048	.4493	1.1317	.74960 (medium)
Overall	4.052	20	<.001	<.001	.47075	.2284	.7131	.53243 (medium)

5.4 Ease of learning

In the second part of the survey, the students were asked to describe their performance after using mobile devices. Out of 21 students, 15 (71.4%) claimed that mobile learning had improved their performance compared with traditional learning. Table 6 shows the frequency distribution of the reasons that students provided.

Table 6. Reasons given by the students for higher performance due to m-learning

Reason	Frequency count	(%)	Rank
Desktop/laptop familiarity	3	14.2	4
Coding practice	4	19	3
Feedback	4	19	3
Easy to learn	5	23.8	2
Understanding	12	57.1	1
Quality learning\save time	2	9.5	5

'Understanding' was cited as the main factor in better performance by 12 students (57.1%), while 'easy to learn' was the second most cited factor (5 students, 23.8%). 'feedback' and 'coding practice' were cited by 4 students each as the cause of their improved performance. Desktop/laptop familiarity was cited by 3 students (14.2%) and 2 cited 'quality learning/save time'.

5.5 Positive and negative aspects of m-learning

Table 7 lists some likes and dislikes given by the students for using mobile learning to complete the quizzes.

Table 7. Positive and negative aspects of m-learning

Like	Frequency count	(%)	Dislike	Frequency count	(%)
Instant feedback	6	28.5%	Losing battery charge when doing quizzes	5	23.8%
Desktop familiarity	3	14.2%	Distraction	5	23.8%
Comfortable with devices	4	19%	Desktop unfamiliarity	3	14.2%
Breaking routine	3	14.2%	Lack of physical interaction	2	9.5%
Saves time	6	28.5%	Limited power sockets in the lecture theatre, chance of losing battery power quickly	4	19%
Using devices is fun	9	42.5%	Cannot manage time\Insufficient\not comfortable	3	14.2%

Of the 21 students, 9 (42.5%) indicated they had fun using mobile devices for learning, which was the most common positive factor. In contrast, the least liked factors were 'desktop familiarity' and 'breaking routine' (3 students, 14.2% each).

Regarding dislikes, the most frequent drawbacks, each cited by 5 students (23.8%), were distractions and worry of losing battery power when doing tests in the lecture hall. Because battery life of the device could run out at any time, 19% of students cited limited power outlets in the lecture hall as a dislike. Of the 21 students, 14.2% disliked being uncomfortable, were unable to manage their time and were unfamiliar with desktops, while 9.5% cited a lack of physical interaction as a drawback.

6 Discussion

This study measured the experience of using mobile learning tools in studying programming. Students' preferences for using mobile learning tools to complete coursework had the highest mean satisfaction at 4.19 out of 5. This result was consistent with the Alferaihi study [36], which found that over 50% of the respondents wished to sign up for m-learning courses again. The results demonstrated that students thought they did better in m-learning than in traditional learning. This is consistent with Alhelih's study [9] and the meta-analysis by Allen et al. [37], which found statistically significant differences in favour of students who used technology to learn. These studies showed that students who used technology to learn performed slightly better on exams and received slightly higher course grades than those taught using traditional methods. In addition, due to the ease of the learning process, m-learning encouraged students to learn more. This may have occurred for many reasons, including the capacity of the m-learning environment to present information in various formats [38]. Also, m-learning satisfied programming students' needs, consistent with Algahtani's [29] conclusion. Direct feedback and time-saving measures also met students' needs, according to remarks in the open-ended responses. According to a study by Greener and Wakefield [39], using mobile technology for teaching and learning has effectively boosted students' self-confidence and ability to meet expectations. According to Algahtani's study [29], m-learning effectively satisfied most students' needs, including their desire for an immediate response from teachers. The findings also demonstrated that mobile instruction aided learning and motivated students to study more.

In this study, most students claimed that various factors had improved their performance. Programming courses that used an m-learning strategy helped students build their programming skills due to understanding the subject and how programming functions. This was in line with Alsaggaf's findings [40] that the constructivist mobile-based teaching strategy aided students in understanding the order in which program code operates. Other factors cited by students contributing to their improved performance included the simplicity of learning, practice with program coding, getting fast feedback and familiarity with mobile devices. Klimova's study [41] demonstrated that mobile apps that give learners instant feedback help enhance students' performance and benefit learning outcomes. The majority of students had favourable opinions toward using mobile devices in lectures. The most noteworthy and positive comment was how much students enjoyed using technology in computer programming classes. This supports the research that mobile devices can increase students' satisfaction and fun [4] [42] [43]. Students also agreed that using mobile technologies helped them receive immediate feedback and saved time, and Alsaggaf's research [40] supports this finding.

However, students emphasised that the primary drawback was the worry that they may run out of battery power while taking their quizzes and a lack of available power outlets for mobile devices in the lecture hall. Concerns regarding using devices in programming sessions also included the possibility of distracting students.

The overall item rating was 3.87 out of 5, indicating that computer programming students were quite satisfied with their mobile learning experience. This degree of satisfaction demonstrates the efficacy of the MoLeCoP framework and presents a clear picture of how m-learning can be beneficial.

7 Conclusion

This study measured the educational experiences of the treatment group students to examine the adoption of the MoLeCoP framework. The study sample consisted of 21 female students in the treatment group who took quizzes in programming classes using the ViLLE software application. A mixed-method technique was used. According to the study's findings, the students in computer programming courses were content with their mobile learning environment to a certain extent. This level of satisfaction indicates the effectiveness of the MoLeCoP framework and provides a clear example of how m-learning can improve the learning process.

The results of this study are useful to Saudi Arabian computer programming teachers. The study can act as a guide for teachers by implementing an m-learning strategy in a programming course. The finding should be confirmed with a larger scope encompassing advanced programming classes because this study based on a cohort from one university cannot address all aspects of deploying m-learning methodologies.

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