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The Impact of Mobile Learning on Students' Attitudes towards Learning in an Educational Technology Course

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Abstract: As technology has explosively and globally revolutionized the teaching and learning processes at educational institutions, enormous and innovative technological developments, along with their tools and applications, have recently invaded the education system. Using mobile learning (m-learning) employs wireless technologies for thinking, communicating, learning, and sharing to disseminate and exchange knowledge. Consequently, assessing the learning attitudes of students toward mobile learning is crucial, as learning attitudes impact their motivation, performance, and beliefs about mobile learning. However, mobile learning seems under-researched and may require additional efforts from researchers, especially in the context of the Middle East. Hence, this study's contribution is enhancing our knowledge about students' attitudes towards mobile-based learning. Therefore, the study goal was to investigate m-learning's effect on the learning attitudes among technology education students. An explanatory sequential mixed approach was utilized to examine the attitudes of 50 students who took an educational technology class. A quasi-experiment was conducted and a phenomenological approach was adopted. Data from the experimental group and the control group were gathered. Focus group discussions with three groups and 25 semi-structured interviews were performed with students who experienced m-learning in their course. ANCOVA was conducted and revealed the impact of m-learning on the attitudes and their components. An inductive and deductive content analysis was conducted. Eleven subthemes stemmed out of three main themes. These subthemes included: personalized learning, visualization of learning motivation, less learning frustration, enhancing participation, learning on familiar devices, and social interaction, which emerged from the data. The researchers recommended that higher education institutions adhere to a set of guiding principles when creating m-learning policies. Additionally, they should customize the m-learning environment with higher levels of interactivity to meet students' needs and learning styles to improve their attitudes towards m-learning.

Keywords: mobile learning; mobile technology; learning attitudes

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1. Introduction

This paper documented several key contributions in the field of mobile technology. One of the major trends in the Information and Communication Technology (ICT) advancement of education is the rapid spread of mobile technology. Mobile technology has positively impacted our lives. As an illustration, it has significantly improved our understanding of modern life's quality and convenience. It has become integral to most people's lives, since they carry mobile devices everywhere [1].

Moreover, the impressive features of mobile devices make it possible to replace some of the operations that would often be performed on desktop or laptop computers [2]. Students can access a variety of online tools on their mobile technology, such as laptops,

tablets, or smartphones in classrooms, to build relationships with other students according to the needs of the learning setting. Students can utilize these tools to study, communicate with one another, and collaborate while doing their coursework in class, from home, or at another location.

M-learning is defined as employing any handheld, portable device connected to the Internet to disseminate learning resources and services to learners. It can be used wherever individuals want, without any place or time limitations [3]. In the present research, we are interested in technology education students' learning attitudes when they learn in a mobile learning environment. By technology education students, we mean those who have participated in a technology education course, where we will describe this course in the methodology section.

Learning attitudes influence the learning variables that influence students' engagement in this learning and thus their achievements. Learning attitudes could be defined as positive, negative, or neutral opinions or sensations that have been posited to comprise affective, cognitive, and behavioral components [4]. Procedurally, they are defined according to the categories and items in the theoretical framework that we follow in this research, which will be described below. It is imperative to assess the learning attitudes of students while using mobile learning, as these influence their behavior, academic performance, motivation, and tasks.

1.1. Significance of the Study

This study is theoretically and practically significant in many ways. In the first place, it bridges a gap in the research literature, focusing on using mobile devices to engage students and provide meaningful learning. Even though some studies have been conducted on the use of m-learning in the Palestinian context [5,6], none have investigated the impact of m-learning as a solution to effective learning. Understanding the influence of mobile learning on students' attitudes can help to improve different classroom variables such as cognitive, metacognitive, social, and other affective variables.

Examining students' attitudes could help in the design and usability of mobile learning tools and ultimately enhance the learning experience for students. Second, recognizing attitudes while using mobile learning will increase the access to educational content for students who may not have access to traditional classroom-based learning. This study will support current teaching practices by allowing teachers, instructional designers, and learning application developers to change their practices to fit their student's characteristics, requirements, and preferences in a better way [2,7–9].

In addition to the need for the present study in the Palestinian context and as answer to researchers' emphasis on its importance, as mentioned above, we had a personal need to carry out such a study, as the authors of the present study are researchers on educational technology, and our past research has included the use of mobile devices in education. The present research is one step forward, as it addresses the attitudes in higher education settings and among educational technology students.

1.2. Statement of Problem

The researchers argued that using mobile devices with diverse applications allows for students to access information from multiple resources, interact with teachers and peers, and collaborate to construct knowledge. Thus, there is a need to integrate m-learning in higher education.

As mobile phones and tablets are available for students and lecturers, they should be effective learning tools. They are handy and easy to use for various purposes. The implementation of mobile technology became a must during the pandemic [3,6]. Therefore, research on this implementation is needed. Hence, this study will add to previous research by exploring the influence of m-learning on student attitudes in higher education institutions by focusing on students' overt attitudes and self-reported information processing. Therefore, this study aimed to examine how m-learning affects university students'

attitudes toward their learning on an Educational Technology course. In the frame of this course, the participants tried to integrate technology tools and strategies while teaching and learning, with an emphasis on creating and designing educational videos.

Following this, we present a literature review related to the constructs on which we focus in the present research, and then we present the results that include the quantitative and qualitative results. Afterwards comes our discussion of the research findings, followed by the research conclusions.

2. Literature Review

In the following literature review, we will address the main topics in which the present research is interested: mobile technologies in learning, attitudes in education, and m-learning and its attitudes. Below, we describe each of these topics.

2.1. Mobile Technologies in Learning

The literature review suggests that using mobile technology in learning (m-learning) is a recent and dynamic concept that has created a new teaching philosophy. Mobile devices are growing faster than the world's population. Students can develop and maintain effective learning by using these devices, which overcomes the time and space limitations of traditional formal learning [10]. Positive effects of m-learning have been identified in engineering [11], literacy [12], science [5], mathematics [13], history [14], and theater art [15].

Nowadays, students regularly use mobile devices to study while on the go [4]. By reducing the reliance on permanent locations for work and study, this mobility enables formal and informal learning contexts [16], which changes how students learn [17]. In Palestine's case, several studies [5,18,19] have been conducted on m-learning, where these studies have included several aspects of students' learning [20–23], but not their attitudes towards this learning.

Many aspects of m-learning were elaborated by Bernacki, and Greene [24], who explained that m-learning facilitates learning across multiple contexts. Furthermore, they discussed how it supports situated learning and enables social connections with peers, educators, and experts related to collaborative learning, sociocultural learning, and self-determined learning. Another study by Kukulska-Hulme [12] supported these aspects and mentioned that m-learning supports situated, contextual, collaborative, and game-based learning. M-learning activities facilitate situated learning by enabling students to learn and use concepts in real-life situations.

Moreover, a previous study by Daher [25] concluded that mobile phones provide new affordances to learners in order to personalize and design their learning and amplify their voices in innovative ways that positively impact this learning by encouraging students' motivation, autonomy, confidence, enjoyment, empowerment, and the understanding of the content.

A series of recent studies [26–28] has indicated that m-learning tools enhance students' thinking by enabling a decrease in their mental effort while processing information. Research on m-learning's impact has recently begun to broaden and include aspects of instructional design, learner interaction, and learning outcomes [29]. This aligns with Salhab and Daher [30], who mentioned that these mobile technologies positively influence students' behavior, emotions, and engagement. More studies are currently addressing mobile tools' effects on the learning process to fit learning styles [24]. Despite the mentioned studies, research is needed on the affective aspect of learning, especially attitudes, which the present research attempts to contribute.

2.2. Attitudes in Education

Attitudes are defined as a taught tendency to assess people, issues, objects, and events in specific ways [28]; these assessments might be positive, negative, or neutral, but they are often inconclusive [7]. Cognitive, affective, and behavioral aspects are constructs

of attitudes that have been identified by many researchers [31,32]. Beliefs make up the cognitive component, feelings and emotions make up the affective component, whereas acts and observed responses make up the behavioral component [33]. Attitudes might affect students' learning process and whether they want to learn or not learn different subjects in the required manner [31]. Attitudes are crucial factors that help them to set goals, solve problems, and change their beliefs toward learning in positive, neutral, or negative ways [7]. Research is needed about students' attitudes towards mobile learning, upon which the present research attempts to shed more light.

2.3. M-Learning and Attitudes

Acquiring information by using mobile technology affects these attitudes [34]. Attitudes are components of the successful implementation of mobile technology adoption. They are essential in determining whether they can implement this technology [9,10]. Students' attitudes play a crucial role in adopting m-learning [35]. This is consistent with findings from other studies that students' attitudes affect m-learning acceptance; they significantly predict students' intention to use mobile technology and influence their behavioral intention [29]. Generally speaking, to date, the literature has revealed diverse results regarding students' attitudes toward m-learning [36], with both negative [37] and positive attitudes [9]. However, in the last few years, several studies have presented favorable attitudes toward m-learning [2,31,33,38].

Mobile technologies contribute positively to students' attitudes toward learning. For instance, Heflin et al. [39] reported that positive student experiences with mobile devices improved students' attitudes toward this mobile technology. This coincides with Fabian et al. [38], who found positive student attitudes towards the use of mobile devices by conducting a quasi-experiment mixed study, since using a smartphone for learning math facilitated the visualization of abstract concepts, improved engagement with fun and active learning activities, and allowed for the personalization and ownership of learning.

This was noted by Al-Emran and Alkhoudary [2], who investigated students' attitudes toward m-learning, concentrating on differences related to gender and smartphone ownership. The data were collected through a questionnaire administered at eight universities in Dubai, United Arab Emirates, to 141 students. The findings showed that male students were more likely to use m-learning systems than female students. Additionally, those who owned smartphones had more positive attitudes toward m-learning systems than those who did not own smartphones. Following this, a study by Çavuş [40] showed similar positive and encouraging opinions of students towards using m-learning. Students could access their course material without effort anytime and anywhere through the MobLrN m-learning system that the researchers developed. Al-Qatawneh et al. [41] also conducted a quasi-experiment on college students. They implemented an m-learning strategy and found a statistically significant difference in the attitudes between the two groups toward m-learning.

Although there are many studies in the literature, research on students' attitudes towards m-learning in the Palestinian context remains limited. It is deemed necessary to verify the previous findings regarding the attitudes towards smartphones about their use in the process of learning on an education technology course in a higher education setting. Hence, the study tries to answer the following main questions:

1. Is there a significant difference between the control and experimental group using m-learning, including its components: emotional, behavioral, cognitive, and overall attitudes?
2. What are the attitudes of technology education students toward m-learning after using their mobile devices?

3. Methodology

3.1. Research Design

A mixed method with an explanatory sequential design was used to investigate the attitudes of technology education students in an m-learning environment. A mixed method design employs different types of inquiry to better understand a phenomenon by combining more than one data collection tool [42]. The sequential approach was used since the quantitative results were followed by the qualitative results; thus, the qualitative findings were used to contextualize, complement, and validate the quantitative data [43]. A quasi-experimental approach with initial quantitative steps was used in this study, with two pre-existing scales for students. Since the researchers wanted to describe the m-learning experience, a phenomenological approach was used for the qualitative step. Both approaches aligned well with the study's objective of studying the impact of m-learning on Palestine technical university Kadoorie (PTUK) students' attitudes through the intervention and implementation of a Moodle mobile application (MMA), designed with an Analysis, Design, Development, Implementation, and Evaluation (ADDIE) course design. A pre-existing scale and post-scale quasi-experimental design were used with a control and experimental group.

In general, mixed-method approaches are argued to be more effective than either quantitative or qualitative approaches alone. This is to say that qualitative data are used to validate quantitative results, which justifies the design choice [44]. In addition, quantitative data were collected, which were then supplemented and enriched with qualitative data [45]. Furthermore, the phenomenology approach was chosen for the qualitative method, because it reflects on lived experience with a specific group or object to arrive at a more profound and deep understanding of a phenomenon [46].

3.2. Research Context

The mixed approach was conducted at the PTUK educational technology course in the second semester of 2021/2022 to answer the study questions. Two groups were involved in the quasi-experiment: a control group and an experimental group that the researchers taught [41]. The intervention was conducted on an educational technology course for the experimental group and lasted for a whole semester, 16 weeks. The researchers designed the Moodle mobile course (MMA). The course design utilized an ADDIE instructional design to create the course model [47]. The course's objectives remained the same, but were enriched with engaging and interactive activities that included some Moodle tools, wikis, discussion forums, interactive HTML5 Package (H5P) videos, micro-learning videos, assignments, gamification platforms, and group work. The mobile Moodle application was used to deliver this course via smartphones and other mobile devices that had already been adapted to the instructional material based on the learner's needs and course objectives.

3.3. Research Context and Participants

The population of this study consisted of students who were third-year and fourth-year students taking an educational technology course at PTUK. The technology education course included the following topics: the history of educational technology, the functions of technological tools in education, the design of physical educational tools, the design of digital educational tools, and electronic learning.

The students in the experimental group learned according to the ADDIE instructional design that was based on mobile learning, while the control group's learning was carried out as usual, using the classroom and computer lab. Both groups learned the same topics.

3.3.1. Questionnaire Respondents

The population of this study was third-year and fourth-year students taking an educational technology course at PTUK. The present study focused on technology education students at PTUK taking educational technology courses. The Technology Education Program works to make students acquire an understanding of current teaching methods and

theories, especially the use of technology in education. This acquisition is achieved while improving their proficiency in solving technological problems. Moreover, this study program focuses on utilizing various technological tools, materials, and processes, as well as enhancing students' abilities in designing, producing, utilizing, and evaluating educational technology-based products and systems, with a particular emphasis on recently developed computer applications.

The participants were third-year and fourth-year students in the program at PTUK. The respondents consisted of 50 students and were chosen purposively (non-random sampling), since they were taking the same course with the same instructor. Non-random sampling could be used because a quasi-experiment was conducted. The respondents were asked to volunteer to participate in this study. Table 1 exhibits the demographic data of the respondents.

Table 1. Demographic characteristics.

Classification	Category	Number	Proportion
Experimental Group			
Gender	Male	6	24%
	Female	19	76%
GPA	Excellent	3	12%
	V.Good	14	56%
	Good	8	32%
Technical Skills	Excellent	4	16%
	V.Good	12	48%
	Good	9	36%
College level	Third level	16	64%
	Fourth level	9	36%
Control Group			
Gender	Male	8	32%
	Female	17	68%
GPA	Excellent	5	20%
	V.Good	12	48%
	Good	8	32%
Technical Skills	Excellent	12	48%
	V.Good	*12*	48%
	Good	1	4%
College level	Third level	16	64%
	Fourth level	9	36%

3.3.2. Focus Groups and Interviews Participants

Small groups of 8, 8, and 9 students who went through the mobile learning experience took part in the quantitative part in the form of three focus groups. These groups included technology education students who were taking the educational technology course, as shown in Table 2.

Table 2. Semistructured interview and focus group participants' description.

	Fictive Name	Gender	GPA	College Level
	Semi-Structured Interviews and Focus Groups			
1.	Tahreer	Female	Good	Fourth
2.	Manal	Female	Good	Fourth
3.	Mohammed	Male	Good	Fourth
4.	Nadia	Female	Good	Fourth
5.	Raneen	Female	Excellent	Fourth
6.	Areen	Female	Good	Fourth
7.	Taymaa	Female	Excellent	Third
8.	Intisar	Female	Good	Fourth
9.	Salma	Female	Good	Third
10.	Deema	Female	Excellent	Third
11.	Badran	Male	Good	Third
12.	Hassan	Female	Very Good	Third

Table 2. *Cont.*

	Fictive Name	Gender	GPA	College Level
	Semi-Structured Interviews and Focus Groups			
13.	Leena	Female	Very Good	Third
14.	Taqwa	Female	Very Good	Third
15.	Rami	Male	Very Good	Third
16.	Shadi	Male	Very Good	Third
17.	Jacob	Male	Very Good	Third
18.	Raneen	Female	Very Good	Third
19.	Ahed	Female	Very Good	Third
20.	Marah	Female	Very Good	Third
21.	Soma	Female	Very Good	Third
22.	Haidi	Female	Very Good	Third
23.	Alaa	Female	Very good	Third
24.	Ola	Female	Very Good	Fourth
25.	Tamer	Male	Very good	Fourth

3.4. Study Procedure

First, a quasi-experimental research method was used to investigate the utility of mobile learning in helping students stay engaged. Two groups, the control group and an experimental group, of educational technology students were assigned. In both groups, pre- and post-scales were used to assess their attitudes. During the intervention, 25 students in the control group received an educational technology course using traditional methods, while 25 students in the experimental group received an educational technology course using the Mobile Moodle application (MMA) over 16 weeks.

At the start of the course, the students in the experimental and control groups were given a pre-existing scale for their attitudes via Google Forms. The educational technology course in the control group was delivered using traditional learning techniques such as lecture notes, PowerPoint presentations, and instructional videos in a computer lab. A mobile-friendly LMS with an interactive course design, as well as the course's lecture notes, were provided to the experimental group. At the end of the 16 weeks, post-scales for their attitudes were distributed electronically to all the students via Google Forms.

3.5. Data Collection Tools

The data collection for the participants was performed sequentially, as typical for an explanatory sequential design. The sequential design was divided into three stages, as suggested by [43]. According to the sequential design, the quantitative data collection and

analysis were followed by the interview data collection and analysis and the interpretation process, as shown in Figure 1.

During the data interpretation and integration phases, the findings from both phases complemented each other [43]. The overall goal of this design was to quantitatively explain the phenomenon under study and delve deeper into the results of the qualitative stage.

3.5.1. Pre and Post Scales

A pre-course attitudes scale was completed by 50 students before the intervention (using a smartphone for the course) for the quasi-experiment design, as a quantitative tool. The scale was distributed online to the control and experimental groups, which made it convenient and easy for the participants to respond, as well as being time-saving and cost-effective for the researchers [48]. The pre-existing scale was validated by its author and there were three procedures involved in this portion: a translation from English to Arabic, validating the scale, and assessing its reliability. A pre-existing scale was used to evaluate the students' attitudes towards ICT [42] and adapted to the context of m-learning, since it has been shown that Information and Communication Technology (ICT) includes wired and mobile infrastructures [49]. We chose this questionnaire because it addressed attitudes towards ICT tools, where mobile devices are but one of them. In addition, the utilized questionnaire underwent validity and reliability tests, which showed its fitness for evaluating these attitudes towards ICT learning.

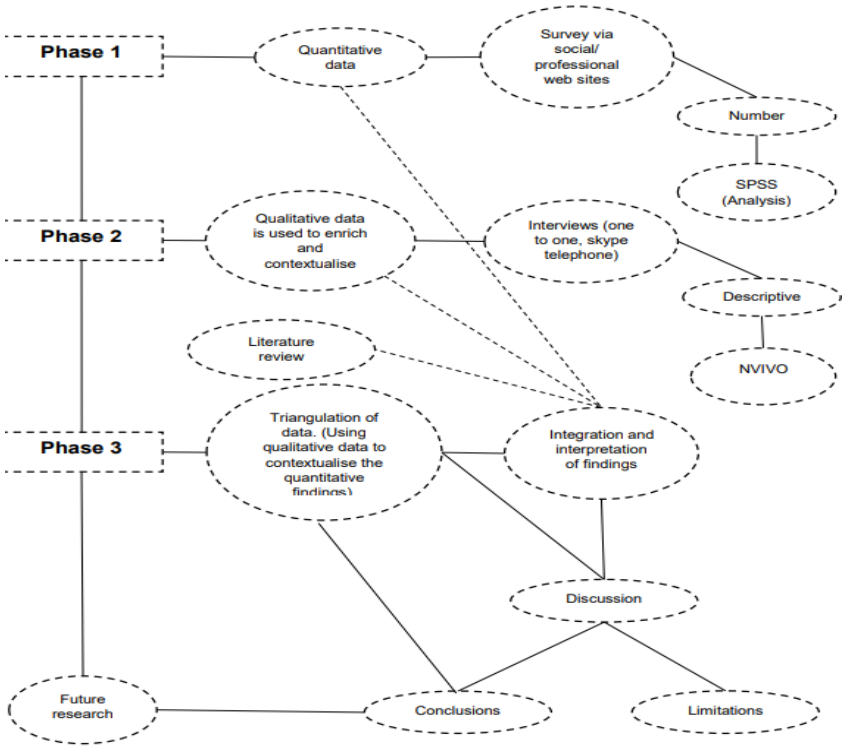

Figure 1. Explanatory sequential design phases as cited by [43].

Moreover, [26] believed that smartphones may be considered as an ICT, since they are a highly portable technology with massive access. In total, 3 constructs with 20 items made up the attitude scale: cognitive (7 items), affective (8 items), and behavioral (5 items). The items were assessed as entirely agree (5), agree (4), slightly agree (3), disagree (2), and completely disagree (1) on a five-point Likert scale.

The scale was validated by assessing the face validity by administering the translated scale to professors from various universities with specialties in education psychology, educational technology, curriculum, and instruction. Because the researcher used a translated scale from English to Arabic, a Pearson correlation was used to evaluate the scale's valid-

ity [50]. To assess the construct validity of the attitudes scale, the Pearson's Correlation Coefficient was calculated to find the correlation between each scale item and the overall degree of the scale to which the item belonged. This resulted in a correlation coefficient that was between 0.621 and 0.882 for the emotional scale, between 0.631 and 0.811 for the behavioral scale, and between 0.677 and 0.834 for the cognitive scale. The correlation coefficients for each dimension with the whole questionnaire were computed, which resulted in values between 0.634 and 0.794. According to the correlation coefficient values of each item with its corresponding dimension, which were positive and statistically significant at a level of significance of (0.01) or less, a good construct validity and suitability were demonstrated for measuring the target variable, as the validity coefficient values were all greater than 0.6 [51].

Cronbach's Alpha was calculated for each of the three attitude factors to ensure the reliability. The internal consistency (Cronbach's alpha) was 0.868 for the emotional factor item, 0.754 for the behavioral factor items, and 0.736 for the cognitive factor items. The total scale had an internal consistency of 0.834, which indicates a high reliability and good level of internal consistency [52].

3.5.2. Focus Group Sessions

Focus group sessions were used to collect qualitative data. A focus group session is a type of group discussion about a topic that is moderated by a trained group moderator [53]. Following the intervention of using the Moodle mobile application, three focus group sessions were held for 8–10 students per session. The participants in the study who used m-learning were voluntarily invited to these focus group sessions. The participants were chosen based on two criteria: they were at least third college level and were enrolled in educational technology courses for the second semester of 2021/2022. The 120 min focus group sessions with 24 participants were conducted via ZOOM and in person in the classroom. Permission was granted by the participants to record the session and the answers of the participants.

The focus group discussions included issues related to the present research topic, where the participants discussed the impact of mobile learning on each component of their attitudes towards learning, namely the cognitive, the emotional, and the behavioral.

3.6. Ethical Consideration

This study was carried out after receiving ethical approval from the university and informed consent from all the participants. Approval from PTUK was received for the experiment. Furthermore, voluntary participation was offered with anonymity of identities when the research was written. Permission was granted from the Institutional Review Board (IRB) at An Najah National University to protect the participants' confidentiality. Additionally, the information of the participants was kept confidential and saved on a private computer that only the researcher had access to.

3.7. Data Analysis Tools

A data analysis followed the sequential design, as it came after the quantitative data collection and before the qualitative data collection. Several statistical tests were used to answer the first question in this study: descriptive statistics, frequency distributions about the control variables, the arithmetic mean, and standard deviation were used to summarize the main characteristics of the sample. An ANCOVA (one-way analysis of covariance) test was used to answer the first question, to see if there was a difference in the attitudes between the experimental and control groups and its components. Many parametric statistical tests should meet the assumption of normality [54]. Since the sample size was up to 50, the Kolmogorov–Smirnov test was used to determine whether the data had a normal distribution of continuous data. To perform the ANCOVA, the criteria of no significance outliers and homogeneity assumptions must be met as well [55]. As shown in Tables 3 and 4, preliminary checks were completed to assess the assumptions of nor-

mality, linearity, outliers, variance homogeneity, and slope regression homogeneity [56]. The Kolmogorov–Smirnov test revealed the post-scale scores for the behavioral dimension W(50) = 0.138, p = 0.062, for the cognitive dimension W(50) = 0.126, p = 0.072, for the emotional dimension W(50) = 0.105, p = 0.088, and for the overall attitude scores W(50) = 0.122, p = 0.194. These findings indicate that the post-scale scores followed a normal distribution. Another assumption, variance homogeneity, was assessed. The assumption of variance homogeneity was not violated for the total attitudes scores and its component, F = 0.425, p = 0.518 for the total scores, F = 0.346, p = 0.559 for the emotional, F = 1.200, p = 0.279 for the behavioral, and F = 1.210, p = 0.277 for the cognitive.

Table 3. Normality test for attitudes (Kolmogorov–Smirnov).

Dimension	Statistic	Df	Sig.
Behavioral post	0.138	50	0.062
Cognitive post	0.126	50	0.072
Emotional post	0.105	50	0.088
Total post	0.122	50	0.194

Table 4. Levene's Test of Equality of Error Variances for attitudes.

Dependent Variable	F	df1	df2	Sig.
Total	0.425	1	48	0.518
Emotional	0.346	1	48	0.559
Behavioral	1.200	1	48	0.279
Cognitive	1.210	1	48	0.277

Note. Tests the null hypothesis that the error variance of the dependent variable is equal across groups. Dependent Variable: total post scores.

An ANCOVA was used to examine the significant difference in the attitudes and their components between the experimental and control groups of m-learning students. The ANCOVA test results showed significant differences in the students' attitudes after the experiment between the m-learning and control groups.

3.7.1. Qualitative Data Analysis

Here too, the qualitative data analysis was conducted according to the sequential design. It followed the qualitative data gathering that came after the quantitative data analysis. This study adopted a phenomenological approach to better understand how technology education students who used mobile technology engaged in learning. The information was gathered using verbatim transcriptions of the focus group discussions and individual interviews. A content analysis of the semi-structured interviews and focus group transcripts, utilizing both inductive and deductive methods, was employed. The content analysis included an abstraction process and material grouping for the researchers to use inductive reasoning to respond to the research questions [57]. To generate the themes that emerged from the participants' responses, an inductive analysis was conducted. The deductive analysis used a framework for attitudes with three components: behavioral, emotional, and cognitive. Table 5 shows the sub-themes and codes of the attitude's components.

Table 5. Themes, subthemes and codes for attitudes.

Themes	Sub-Themes	Codes
Emotional component	Motivation Self-concept Fewer learning frustrations M-learning fun	Feeling enthused, the instructor motivates Showing my uniqueness, self-esteem Appealing content, feeling satisfied
Cognitive Component	Flexible learning Personalized learning	Easy access to material anytime and anywhere Remembering, memorizing, analyzing
Behavioral component	Enhancing participation Learning on familiar devices Social interaction Gender stereotype and equity access	Share thoughts takes part in the discussion, takes part in activities, answer questions, and post comments, Using my device, I use my device frequently I started to talk with males, I have access to material

The sub-themes in Table 5 led the data analysis process, i.e., the analysis attempted to find data units that fit one of the sub-themes for the attitudes towards mobile learning. This was performed through focusing on the codes related to each sub-theme.

3.7.2. Trustworthiness

To validate the qualitative data derived from the focus group sessions and semi-structured interview questions, the credibility was assessed by the engagement of the researchers in the intervention process of m-learning usage and a data triangulation of the data, which involved different data collection tools such as interviews, focus groups, and course logs. In addition, member checking was performed as a validation technique, where the researchers went back to the participants at a later stage in the research to hear their responses to the results [58]. The code and recode strategy was used to ensure dependability. Additionally, the two researchers coded the data and discussed the analytical processes performed. For transferability, the researchers described the study's context, including the course material, and attempted to allow the reader to determine whether the work was transferable to their context. As a result, the study's findings from this group could be transferred to another. By the same token, a detailed description was provided to the reader to provide detailed contextual information [59]. The researchers used confirmability by documenting the procedures for checking and rechecking the data throughout the study. The findings were based on the participants' narratives and words, rather than potential researcher biases. Trustworthiness was also achieved through saturation, as no new codes appeared in the last two interviews [60].

4. Results

This study aimed to investigate the impact of m-learning on the attitudes of technology education students taking an educational technology course, examining the impact of using a Moodle mobile application through quantitative and qualitative approaches.

We will start by presenting the quantitative results that were related to the first research question, and then we will present the qualitative results that were related to the second research question.

4.1. Differences in Students' Attitudes towards Learning Due to M-Learning

An ANCOVA was performed to investigate the effect of m-learning on students' attitudes and their components and to estimate the effect size by Eta squared (η^2).

The ANCOVA in Table 6 shows that, after controlling for the pre-intervention attitudes scale score, there was a significant difference between the means of the two groups due to the effect of m-learning usage on the attitudes and their components.

Table 6. ANCOVA for attitudes.

DV	Source	SS	Df	MS	F	Sig.	$^{2}\mu_{p}$
Emotional post	Emotional pre	3.967	1	3.967	10.981	0.002	0.189
	group	22.409	1	22.409	62.039	0.000	0.569
	Total	346.469	50				
Behavioral post	Behavioral pre	0.135	1	0.135	0.557	0.459	0.012
	Group	23.840	1	23.840	98.106	0.000	0.676
	Total	361.737	50				
Cognitive post	Cognitive pre	0.502	1	0.502	1.531	0.222	0.032
	Group	20.912	1	20.912	63.753	0.000	0.576
	Total	358.577	50				
Total post	Total pre	0.011	1	0.011	0.045	0.834	0.001
	group	24.288	1	24.288	98.870	0.000	0.678
	Total	361.737	50				

The effect size was calculated by partial eta squared, which showed $\eta^2 = 0.569$ for the emotional component, $\eta^2 = 0.676$ for the behavioral, $\eta^2 = 0.576$ for the cognitive component, and $\eta^2 = 0.678$ for the overall attitudes. The preceding results illustrate that there was a significant difference between the means of the attitudes and their components in the group of students who used m-learning for the educational technology course compared to the control group. Considering both, these results illustrate that m-learning causes a change with 57.6% of the total variance in the attitudes occurring as a result of its usage. The estimated means are shown in Table 7.

Table 7. Estimated Marginal Means of attitudes scores and their component.

Dimension	Group	Mean	Std. Error	95% Confidence Interval	
				Lower Bound	Upper Bound
Total post	Experimental	3.251 [a]	0.099	3.051	3.450
	Control	1.855 [a]	0.099	1.656	2.055
Cognitive Post	Experimental	3.183 [a]	0.115	2.952	3.413
	Control	1.887 [a]	0.115	1.656	2.118
Behavioral Post	Experimental	3.262 [a]	0.100	3.061	3.463
	Control	1.844 [a]	0.100	1.643	2.045
Emotional post	Experimental	3.144 [a]	0.121	2.902	3.387
	Control	1.796 [a]	0.121	1.553	2.038

Note. [a] stands for adjusted group means.

From the estimated marginal means shown in Table 7, it is seen that the two groups had different attitude scores due to their mobile learning usage. It shows that there was a significant difference between the estimated mean post-test attitudes scores of the students taught with m-learning and those who were not.

4.2. Students' Attitudes towards M-Learning: Qualitative Results

To answer the question: "What are Technology Education students' attitudes towards m-learning?", the data from the focus groups and interviews were analyzed. Three themes were identified for determining these attitudes toward m-learning. The answers were given by creating ten sub-themes for the themes that were coded and analyzed, according to the "positive", "negative", and "neutral" directions. Moreover, in the focus group discussions, the interviews were based on three components of attitude, which were the cognitive, behavioral, and affective components [61]. The themes and subthemes are as follows:

4.2.1. Cognitive Component

This refers to the cognitive experience underlying attitudes. This component includes knowledge and beliefs about m-learning. This component had two subthemes.

Personalized Learning

Students show an interest in m-learning and learn in different ways. They prefer to learn with other choices according to their learning styles and like a variety of instructional materials—videos, audio, and other multimedia formats. In total, 22 students showed that they supported m-learning, as it individualized their learning, while 2 students showed negative attitudes toward this sub-theme of m-learning. A student asserted: "I suppose that with m-learning, I recognize concepts easier, with mini videos that break the information into short ideas." This illustrates the students' beliefs that m-learning created positive attitudes for the students who took this course.

Visualization of Learning

Most participants believed that the use of m-learning during lectures helped them to visualize abstract concepts in this course. A student explained: "M-learning is able to clarify abstract concepts like Dale's pyramid in this course. It made me grasp them easily compared to traditional teaching". This shows that the participant believed that using m-learning contributed to a greater understanding of the concept in this class.

4.2.2. Behavioral Component

The component "behavior" encompassed the behavioral experiences involved in the formation of the students' attitudes toward m-learning in the educational technology course. This component also included overt actions toward m-learning and intentions to act. Four themes were identified in this component.

Enhancing Participation

M-learning activated student participation; they learnt without shyness and being watched by their classmates. All the students had positive attitudes towards m-learning in terms of it increasing their participation. A student reported: "I never participated in during lectures in a classroom, I always felt that my voice does seem good enough, m-learning makes it easier for me to participate in forums and posting tools, this made a difference for me." This shows that the student believed that m-learning could have a good influence on student participation, as a subtheme of the behavioral component of their attitudes.

Flexible Learning

One of the prodigious things that the Moodle mobile application offered, in relation to learning, was flexibility with no time and space limits. The students expressed their positive attitude towards using mobile learning in the classroom due to the different flexibility options that m-learning offered such as a flexibility of time, flexibility of content, and flexibility of teacher contact. In total, 25 students expressed positive attitudes toward the behavioral component of flexible learning.

For instance, two participants said: "Yes, I think that the mobile Moodle app can enable me to work offline. It can enable me to browse course contents offline with no hassle and participate in learning activities". This shows that the students considered m-learning as helping them to study and access information anywhere, anytime.

Learning Using Familiar Devices

M-learning has shifted the types of devices that learners use when they learn. They are familiar with smartphone usage and feel comfortable with them. Most students showed positive attitudes towards this subtheme. A student commented:

"We got used to using college desktops which causes privacy issues like not logging off your account or forgetting personal stuff like images. I think that m-learning can resolve this problem". It seems that the students considered mobile devices with their different platforms as ideal for delivering concise and engaging learning content in various formats to learners.

Social Interaction

Learners these days are equipped with skills that enable them to learn on their own, while they can establish connections with others. M-learning accounts for the huge popularity of social media sites and apps that give a learner chances to interact. A student clarified his beliefs regarding the use of mobile learning: "I believe that using my mobile device can enable socialization with peers and instructor". This shows that most students believed that m-learning could increase their interaction with their peers and their instructor as well. This suggests that if learners show positive attitudes, they can establish online learning communities along with their in-class peers that they barely interact with.

Gender Stereotype and Equity Access

As gender equality has been a concern in developing countries, m-learning provides a safe and conducive environment for both genders to interact with sufficient and diverse resources. A student stated, "This is the first class that I collaborated with male students as they help me when I need help and I ask them for help without thinking about gender issues. I believe that mobile learning makes the collaboration fruitful between females and males". This illustrates that the students showed positive attitudes towards m-learning usage as it reduces the gender gap between students.

4.2.3. Emotional Component

The emotional component of the attitudes was related to the likes and dislikes about m-learning in this context, where participants expressed their feelings.

Self-Concept

M-learning helps students to interact by publishing comments and thoughts to show their ideas. Many students mentioned that m-learning activities facilitate learners to show them how they want to be seen or how they want to see themselves. Only 18/25 participants declared that m-learning affected their self-concept. A student commented, "I am working on interesting and challenging activities that make me think and show the best in class." It seems that the participating students considered m-learning activities as helping them increase their sense of ownership; students felt responsible for their learning and used their strengths to express their ideas.

Fewer Learning Frustrations

Many students explained that the learning strategies that were used affected the learners to have positive attitudes and complete the course, involving chunks of content that they enjoyed learning compared to the bulk of information that they used to assimilate in traditional teaching. Fortunately, the students clarified that m-learning minimized many frustrations that the students used to experience during traditional teaching. A student articulated: "What I like the most about this class is the small snippets of m-learning material the instructor designed instead of the long boring lecture that we are used to." This points out that m-learning influenced the students' attitudes positively, as the design of the course was based on content segmentation and reducing big concepts into bite-sized ones, so the learners did not feel bored.

Motivation to Study

Many students mentioned the desire to experience m-learning in this course. The participants reported a wide range of motivators for them to persist while learning, with their peers and the instructor as being the most important. A student stated: "This class was different in terms of sharing my opinions on many tools like Padlet, google documents, and forums. I believe mobile devices motivate students to share their opinions" This implies that m-learning affected the students' attitudes by having motivating content and a motivating instructor.

M-Learning Fun

The Moodle m-learning application activities seemed enjoyable to complete. The students mentioned how content such as mini-instructional videos, blogs, gamification, and short presentations was compelling and visually pleasing for them. Most students expressed positive attitudes towards m-learning. A student claimed: "I believe the gamification tools like Word wall make the learning process more rewarding for the students." This identifies positive attitudes towards the m-learning process, which is fun for mobile learners and makes it easy to consume and improve knowledge using gamification tools.

5. Discussion

Mobile learning has been attracting the attention of educational researchers for a long time [62–66]. The present research intended to study students' attitudes toward this learning in a university course. The results showed that the attitudes scores of the group of students who used m-learning were significantly higher than the group of students who did not use m-learning. The interviews and focus group discussions (FGDs) showed that there was an effect on the cognitive, emotional, and behavioral components of these attitudes, respectively, while using mobile devices to access learning content. These findings were in line with the study conducted by Özcan [67], who explored the effect of m-learning on the attitudes of college students, with the results revealing statistically significant differences in the attitudes and their components. Moreover, all the other attitude scores were also affected positively and were consistent with previous studies [9,35,68] that reported the effect of m-learning on attitudes, due to the many characteristics of m-learning such as increasing motivation, accessibility, portability, ease of use, and enhancing cognition.

Most of the students in the interviews showed positive attitudes towards m-learning due to the potential for personalized learning, learning with enjoyment, and interaction with their peers. The cognitive component of the attitudes obtained a moderate effect size and the highest share among the other themes of the attitudes from the interview and FGD analysis. The finding could be due to that the cognitive component of the attitudes refers to the knowledge, views, and opinions that were related to an object [69]. The students' views and opinions showed the prodigious impact of the Moodle mobile application, as it offered personalized learning.

Most students showed that they supported m-learning, as it individualized their learning according to their needs and preferences. Personalized learning helps students to accomplish their learning goals according to their learning needs. Hereafter, it appears that m-learning with its tailored activities enables students to understand concepts, recognize relationships between ideas, and visualize abstract concepts. Additionally, students can use their own devices, access the resources they prefer, and conduct the research they need for information. These findings go hand in hand with the study of [70], who reported that m-learning benefited students of different learning styles in their personalized learning, as it gave students more freedom and enabled them to recognize their weaknesses and personalized problems in the courses, while using different resources that they selected upon their preferences.

For the behavioral component of the attitudes, there was a significant difference in this component between the two groups, which was in favor of the experimental group who used m-learning, with a large effect size. This differed from the interview and FGD results, where this theme had the second share among the other themes. The highest share of the behavioral component of m-learning belonged to the sub-theme of flexibility. The researcher explained that this positive attitude due to m-learning might enable students to spend more time collaborating and interacting positively with their peers, as well as more time presenting their work and commenting on other work, which fortifies this behavioral component of the attitudes. This was in line with [58], who clarified that flexible learning enables students to spend less time being taught explicitly and working individually in traditional classrooms, with significantly less time being spent in a whole-class setting, and more time working in groups, relative to traditional classrooms.

The results also showed that there was an additional significant difference in the emotional component of the attitudes between the two groups. The experimental group's emotional component scores of their attitudes were higher than those of the control group. The effect size was also moderate among the other components. Many students in the interviews and FGDs showed an interest in m-learning, which affected learners to have positive attitudes and complete the course, involving chunks of content that they enjoyed learning compared to the bulk of information that they used to assimilate in traditional teaching. This finding was confirmed by [9], who indicated that students expressed their enjoyment and enthusiasm in writing when they used their mobile devices. In addition, the researchers explained this effect as being due to the mobile audio-visual learning characteristic that facilitates learning by making it more appealing and faster to use and download compared to regular desktops, which also affects these emotions.

Based on these findings, the researchers suggested that instructors should always design a motivating m-learning environment that takes into consideration students' needs, satisfaction, and social interaction. The ADDIE design seemed to work perfectly with m-learning in this course. This finding conquers the study of [47], who reported the efficiency of using the ADDIE model for creating a cooperative and interactive m-learning application.

6. Conclusions

This study provided insight into PTUK students' attitudes when they used mobile learning. The results of the first question, related to the significant difference between the control group and experimental group using m-learning, including its components, emotional, behavioral, cognitive, and overall attitudes, showed that there was a significant difference in all the components and overall learning attitudes.

Furthermore, the results showed that mobile learning affects students' attitudes positively, with some differentiation between their dimensions. Because m-learning does not only involve using mobile devices for transmitting information to learners, instructors should also consider learners' learning styles and attitude characteristics. Hence, analyzing content, using interactive tools, setting proper objectives, identifying how to deliver content, selecting activities, and assessing learning outcomes are significant steps in designing a meaningful mobile learning environment.

Educational researchers have shown that m-learning positively influences students' attitudes toward m-technology (e.g., [71]). This was also shown in the participants' responses related to the second research question. In the present research, we showed that this positively influenced students' attitudes towards m-learning itself, when learning occurred in the frame of a technology education course.

7. Research Limitations and Future Research

As the present study utilized a mixed-approach method, future quantitative research should be conducted with a broad selection of college students to study attitudes towards m-learning, with more demographic variables such as college level, digital skills, grade point average (GPA), academic specialty, social status, and academic standing, in order to investigate students' attitudes in a mobile learning environment. Another limitation was the course design model, which was ADDIE, and more efforts should be dedicated to the instructional design process for mobile activities. Moreover, the researcher was a lecturer who carried out the intervention in this course. To minimize this limitation, the data trustworthiness was assessed as described in this study. Future research could be conducted in different settings.

8. Recommendations

The findings of this study are crucial for further research, and subsequent work could be carried out to strengthen the m-learning field. The use of controlled studies to investigate student involvement using learning analytics is advised for future research.

In addition to the current research in the field, additional quantitative research with an experimental design is required to explore students' attitudes towards m-learning, with many demographic variables that have not been investigated in this study, such as academic year, social status, economic statutes, and technological expertise, to see if these affect students' attitudes in mobile settings in different disciplines.

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