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Usability Aspects Related to the Use of M-Learning in Elementary Schools in Palestine

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Abstract*: Learning Chemistry course is considered as a difficult task for many learners especially for elementary school students. This is related to understanding different concepts chemical reactions atoms structures, physical representations of molecules, etc. One way to facilitate the learning process of chemistry course is to use Mobile Learning (m-learning) technology. M-learning has different added values compared to classical learning materials such as text book, pictures, etc. Among the different added values of using mobile in educational contexts is the fact that smartphone has richer interaction techniques. Furthermore, smartphones and tablets PC are considered as more attractive for students. Also, there has been a rapid growth in the mobile technology concerning hardware and software. Accordingly, with the widespread use of smartphones and tablets, researchers start investigating the use of such devices in different educational contexts. The use of mobile learning is considered as a recent trend in Palestinian elementary schools and there is a minimal research attention has been directed to the student's attitudes and satisfaction in using m-learning in their learning process. Therefore, our work aims at investigating the use of m-learning by students in elementary schools in Palestine. In particular, we focused on female students as in general female students show less interest in science and technology than male students. We were keen to investigate whether the use of m-learning could change this attitude. Therefore, an educational mobile application called ChemApp was developed to help learners to learn different concepts in chemistry course such as elements' order in the periodic table, electronic distribution, atomic and mass numbers, chemical bonds and formula. By using the ChemApp, the students are able to interact with different components to explore the possible reactions in an interactive interface, to understand the structure and shape of atoms and molecules. The ChemApp was evaluated by a class of 13-14 years old (8th grade) students in a Palestinian primary school. The total number of participants was 30 female students. After analyzing the results, we conclude that these female students had a positive attitude toward the use of m-learning in their learning process of chemistry course. The results of this research work can be considered by policy and decision makers in educational institutions.

Keywords* : usability, mobile learning, chemistry, elementary school students.

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I. INTRODUCTION

With the steady increased spread of smartphones and tablets (mobile devices), researchers started investigating the use of such devices in different educational contexts [1]–[3]. Furthermore, recent hardware technologies along with different software applications make a wide range of mobile-based applications for educational purposes possible. The use of mobile devices for learning purposes is called mobile learning (m-learning) [4].

There are different advantages of using mobile devices in an educational context. The advantages include availability and accessibility of learning resources anytime and anywhere, ability to interact with different types of content, including text, images, audiovisual resources, and animations. Moreover, there is a possibility to support collaborative learning and interaction between students and learners who are in different locations [5], [6]. Another interesting advantage is related to the ability of using spatial visualization which increase student's understanding and cognitive achievements [7].

Due to the previously mentioned advantages, mobile learning can be considered as a promising, emerging technology to support the learning process. Therefore, there has been an increase in the efforts of educational institutions to adopt the use of mobile learning. Furthermore, scientists proposed different solutions to support children and students in their daily learning [3], [8].

It is generally known that the process of teaching and learning in elementary and primary schools is mainly using the conventional methods such as using chalkboards, textbook and graphical illustrations. However, because of the digital society in which children grow up, these conventional methods are not anymore enough to keep the interest of students [9]. Different studies show that there is an improvement in learning achievements when m-learning is used [3], [10]. Based on a number of reviewed studies presented in [3], it was shown that mobile learning facilitates students' affective learning outcomes. Previous studies came up with such findings based on the results from conducted evaluations.

However, based on a recent study [4], only 10% of proposed m-learning applications are related to science and engineering. Most of the proposed mobile learning applications are related to learning a second language [3], [4], [11], [12]. Therefore, there is still a need to investigate the use of mobile learning solutions in the context of science courses such as chemistry, physics, etc. [13].

A number of studies propose using mobile learning technology in the context of learning chemistry in schools. For instance, researchers in [13] proposed the use of a mobile learning application to visualize the different steps in organic chemistry reaction by enabling students to compose the chemical bonds between atoms using touch screens. The evaluation results show that mobile learning has a positive effect on the student's learning outcomes when the students have high learning independence (students engage in a mutual learning process rather than depending only on books and teachers explanation). By contrast, students with low learning independence have lower learning outcomes. Another work propose the use of QR codes with a mobile application to help students understanding the periodic table [14]. Other research work propose the use of Augmented Reality mobile applications to help students understanding chemical reactions between different atoms and molecules, and other learning purposes [15]–[19]. These studies showed interesting results related to the students' attitudes toward the use of mobile applications in learning chemistry course.

However, also other aspects are important for the success of a mobile learning application. According to the reviewed literature in [20], attributes such as efficiency, effectiveness, learnability and user satisfaction are considered as the top usability quality attributes for mobile learning applications. For instance, [21] considered learnability as one of the important fundamental usability attributes, meaning that the mobile application needs to be easy to learn especially by novice users. Other studies, e.g. [22], showed that user satisfaction can determine whether the content has a value to the user or not. Also, user satisfaction is related to having both user guidance during the use of the mobile application, and a visually appealing interface [20].

A number of studies evaluated the use of mobile learning for usability. For instance, researchers [23] concluded a positive acceptance of the use of mobile application in learning vocabulary by the students based on the good scores given to aspects such as ease of use and usefulness. An experimental study in elementary schools was presented in [24]. The results of the study showed that the mobile application enhances pupils' learning attitudes and learning achievements.

Less research attention has been directed toward the Palestinian students' attitudes, satisfaction and perception for using m-learning in elementary school. Furthermore, according to the recent strategic plan (2017-2022), the Ministry of Education and Higher Education in Palestine moves towards "digitalizing education to make milestone change in the educational process"[1]. There were several attempts to propose different mobile based solutions and investigating students' readiness to use m-learning [25], [26]. For instance, the work reported in [25] investigated the teachers' willingness to and attitudes towards the use of m-learning applications in a higher education institution. The results show that the participants perceived positive affordances such as making learning enjoyable, meaningful and accessible. However, the participants also raised some challenges. The challenges are related to lack of experience and knowledge in integrating mobile learning in their courses. Also, lack of resources and applications for content, limited connectivity and unreliable Internet connection with Wi-Fi and 3G/4G networks in Palestine were also mentioned by the participants. Another study [26] shows a high percent of students who are aware of mobile learning and are willing to use it in their courses. However, the previous mentioned studies are conducted in the context of higher education institution rather than elementary schools.

The focus is on female students because in general female students show less interest in science and technology than male students. In addition, a recent world bank report [27] emphasizes the need to encourage female students to complete their 12 years of education as this can increase economic benefits. Another concern is related to the limited number of educational mobile applications that are available in the Arabic language. There are a number of mobile applications proposed with Arabic contents [28]–[30], and the authors of [29] report on a comparison usability study for two Arabic mobile learning applications designed for children with special needs. Finally, a number of studies proposed a set of guidelines related to developing Arabic mobile applications [31], [32].

This research aims to help pupils in learning chemistry. There are different reasons for focusing on chemistry. First, learning different properties of chemical materials is important to be mastered by elementary school students because it is one of basic concepts of chemistry. The difficulty will only be increased when the students start learning about chemical reactions. Another difficulty is related to learning the different learning concepts presented in the periodic table.

This study is useful on three aspects. First, innovative m-learning solutions need to diminish the difficulties that elementary school' students face during learning chemistry. Secondly, it helps to enrich teaching resources with the Arabic language so that teachers can use them in their classroom in Palestine. Thirdly, it is useful for identifying and implementing strategies for adopting a new learning method [33], [34]. Therefore, this conducted research work provides useful details for ministries of elementary and higher education in Palestine. The paper is structured as follow: the next section presents the research question to be answered by the study, as well as an explanation of the developed mobile application and the method applied: setup, sample, instrument, and data analysis principles are explained. The following section presents and discusses the results obtained from the participants. Finally, last section concludes this article and presents future work.

II. MATERIALS AND METHODS

This section presents the research question. After that, a brief explanation about the developed mobile application is presented. Finally, the steps of the conducted evaluation are explained.

A. Research Question

The main goal of this research work is to investigate Palestinian female pupils' attitude toward using mobile application in a chemistry course.

[1] http://www.lacs.ps/documentsShow.aspx?ATT_ID=34117.%20

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Accordingly, this research work will answer the following research question "What is female pupils' attitudes towards using mobile application to learn in a chemistry course in a Palestinian elementary school?".

B. Educational *Mobile Application*

To be able to explore pupils' attitude toward the use of mobile applications in learning chemistry, an Android mobile application was developed. The application can be installed on smartphones and tablets that are running the Android operating system. The mobile application is called *ChemApp*. It facilitates pupils' learning and overtaking misconception about learning concepts that are related to the chemistry course in elementary school.

ChemApp includes learning contents and functionalities that are provided to support pupils in their learning process. The learning contents are categorized into two types; teaching materials and interactive multimedia resources. Functionalities related to games, and quizzes are also integrated in the *ChemApp* application.

Teaching materials include explanations based on the lessons that are available in the course's book. The explanations are created using whiteboard animation technique. This technique is imitating the use a whiteboard surface and marker pens by authors to physically draw, brush and record illustrations for specific concepts. The animations are supported by script narration.

For supporting the creation of learning content and other functionalities, a number of IDEs[2] have been used. For instance, Adobe Audition has been used to record audio files and edit some parts to be able to integrate them with animation files. To create whiteboard animation files, VideoScribe software was used. Both Photoshop and illustrator were also used to draw illustrations, graphic characters, graphs, etc. Finally, Unity was also used to integrate the different modules into a mobile application. Furthermore, Unity can generate application for different platforms such as iOS and Android. Finally, C# scripting language was used as programming language for implementing the different functionalities and the user interface.

The main interface of the application is divided into two parts (see Fig. 1). The first part (upper part of the canvas highlighted in orang color) includes eight lessons created using whiteboard animation and the second part (lower part of the canvas highlighted in blue color) includes a number of modules: an interactive periodic table, chemical reaction equations, an interactive chemical lab, electron configuration, and a molecule game. It also has a hint bar which displays some notes that are available for each lesson in the course's book. Furthermore, the learner can mute the music or sound that is played once the *ChemApp* is launched.

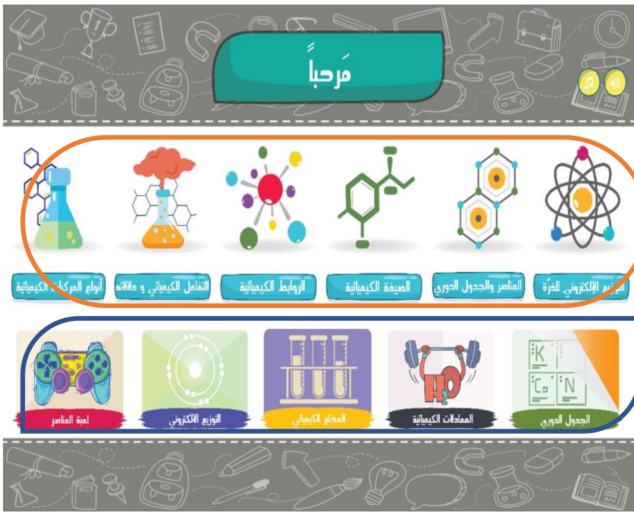

Fig. 1. ChemApp main interface

C. Evaluation Setup

The conducted evaluation focused on both usability and acceptance by pupils when using *ChemApp* in a chemistry course in an element school. The evaluation was conducted inside a classroom in a Palestinian school with a class of female pupils. The evaluation took place during a one-hour session and consisted of the following three steps. First step: it was not expected that the pupils could interact immediately with *ChemApp*. Therefore, a 10 minutes introduction was given to the teachers and pupils by one of the researchers. She showed the different functionalities that are provided in *ChemApp*, i.e., she showed the pupils how to use the whiteboard video lessons. Also, she explained how to use the interactive periodic table, the chemical reaction equations and the interactive chemical lab, the electron configuration, and the game.

The second step involved using the application by 30 pupils who were asked to formulate groups of 5. Accordingly, there were 6 groups and each group was given a tablet that has *ChemApp installed*. Fig. 2 shows a group while interacting with *ChemApp*. The students were asked to try out the application by themselves for 10 minutes. Each group interacted and explored the different components of *ChemApp*. It is important to mention that there were 5 teachers who were used as observers; they did not help or give instructions to the pupils during their exploration of the app.

[2] Integrated Developing Environments

Fig. 2.Group of pupils interacting with ChemApp

In the third step, the (paper) questionnaire was distributed and the pupils were asked to fill them out. For the questionnaire, the pupils could ask clarifications about the questions. After that, the questionnaires were collected and analyzed.

D. Sample

As mentioned earlier, the evaluation was carried out with 30 female pupils from one Palestinian primary school in Jenin. The students were 13-14 year old and in a class of the 8th grade. All the pupils were following a chemistry course. Because of the research objective, only female pupils were considered in this evaluation. To avoid having biased evaluation results, the pupils were informed that the participation in the evaluation was voluntary. Furthermore, they would not be evaluated for their evaluation and the questionnaire results would be anonymous. More demographic detail about the participants is given in the results and discussion section.

E. Instrument

A quantitative evaluation approach was considered in this research work. The adopted approach was used to obtain objective results. To reveal subjective feedback, a qualitative evaluation was used also allowing to check the consistency of the obtained results. Moreover, all questions were translated to the Arabic language to made it easier for the pupils to give their opinion and to avoid misunderstandings.

The instruments for the evaluation were adapted from related studies. For instance, the instrument proposed in [35] was used to evaluate the Learner's Performance (4 questions), Satisfaction (3 questions), and Behavior (4 question). The System Usability Scale (SUS) [36] was utilized to measure Learner's Motivation (4 questions), Perceived Usefulness (4 questions), Usability (10 questions), and Ease of Use (3 questions). A number of these instruments were also adopted in similar studies discussed in [20]. The questions used for the qualitative evaluation were adopted from [37].

The compiled questions were reviewed and approved by a group of referees who have publications related to usability evaluation for mobile application. Moreover, five chemistry teachers were involved in giving feedback on the formulation of the questions before conducting the evaluation. The given feedback was not only related to language issues but also to improving clarity and the relevance of the questionnaire's items to the research goal. At the end, the feedback from both referees and teachers was considered and modifications were applied to the questionnaire to take the feedback into consideration.

To ensure an objective evaluation, a number of actions were taken to avoid biased evaluation. For instance, for the questionnaire the pupils were informed that there were no correct or wrong answers. Furthermore, they were asked to fill out the questionnaire anonymously so without mentioning their names. They were also encouraged to provide a critical evaluation in order to help improving and enhancing some important aspects related to quality, usability, and usefulness of *ChemApp*. Another action was related to the use of negatively formulated questions as well as positively formulated questions. Based on the results of positively and negatively formulated questions, contradictory results could be identified and removed Furthermore, the questions were formulated with care to avoid leading the participants to give more favorable answers [38].

F. Data Analysis Principles

The score used for the answers in the questionnaire was a Likert scale (1-5), 1 for strongly disagree to 5 for strongly agree. Numbers from 1 to 5 were assigned to each response option. Therefore, a single item score is used to assign individual score to each question for each participant in this evaluation. The single item makes it easier to identify the questions that were given a good score and others that were given a negative score.

A good score was defined as follow: positively formulated questions are considered as "good" (positive score) when the average of the results is 3 or higher. On the other hand, negatively formulated questions are considered as "good" (positive score) when the average of the responds is 3 or fewer.

Concerning the interpretation of the evaluation results, we have opted for the following rules: For positively formulated questions, average values between 4.00 and 5.00 were considered as a good to perfect evaluation; average values between 2.50 and 3.99 were considered as a neutral evaluation, and average below 2.49 indicated a rather poor evaluation and suggested that improvements are needed. For negatively formulated questions, these rules are reversed so that the lower the average, the more positive the evaluation is. Accordingly, the interpretation for the responds of negatively formulated questions is as follow: Average values between 1 and 2.49 were considered as a good to perfect evaluation; average values between 2.50 and 3.99 were considered as a neutral evaluation; and average more than 4 indicated a rather poor evaluation and suggested that improvements are required.

III. RESULTS AND DISCUSSION

This section explains the evaluation results in term of general information about the participants, and questionnaire's answers.

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A. Participants Data

As noted earlier, the evaluation was conducted with a group of 30 students who have almost a homogeneous background about using mobile technology in learning. For instance, answering yes/no question "Do you know learning by using mobile device?", 27 participants answered positively on the previous question. As presented in Table I, more than 50% of the students are using a mobile phone on a daily basis. However, the majority of the participants (more than 20 participants) are not using educational mobile applications often. Such result is expected because of the limited number of available educational mobile applications in the Arabic language that can help pupils to understand topics related to their school courses.

TABLE I: PARTICIPANTS DEMOGRAPHIC DATA

Questions	> 3 times	2-3 times	Once	Never
How many times do you use mobile phones or tablets every day?	24%	40%	26%	10%
How often do you use educational applications in a day?	10%	16%	66%	8%

In general, the gained results related to usability and students' attitude were positive as shown in Table II. The table presents the categories with their corresponding evaluation (Good, Neutral, or Poor). 26 questions were rated as good, distributed as follow: 4 questions for learner's performance, 1 question for learner's satisfaction, 2 questions for, learner's behaviors, 4 questions for learner's motivation, 3 questions for perceived usefulness, 10 questions for usability, and 2 questions for ease of use. On the other hand, there were 7 questions rated as neutral, distributed as follow: 2 questions for learner's satisfaction, 2 questions for learner's behavior, 1 question for perceived usefulness, and 1 question for ease of use. Finally, no questions had poor results.

TABLE II: SUMMARY OF QUANTITATIVE EVALUATION

Category \ Score	Good	Neutral	Poor	Total
Learner's Performance	4	0	0	4
Learner's Satisfaction	3	0	0	3
Learner's Behavior	2	2	0	4
Learner's Motivation	4	0	0	4
Perceived Usefulness	3	1	0	4
Usability	10	1	0	11
Ease of Use	2	1	0	3
Total number of all questions				**33**

Next more details for each category is given by means of corresponding tables. For readability concerns, we have indicated negatively formulated questions in italics, whereas the positively formulated questions are written in standard font format.

As shown in next table (Table III), which shows the results for Learner's performance, all answers for the 4 questions were positive. The pupils mentioned that the use of *ChemApp* could help them to enhance both their skills and understanding of chemistry concepts. Furthermore, the majority of the pupils found that the use of *ChemApp* enabled them to peform the learning task more quickly. Concerning question 4, which is a negatively formulated question, most of the pupils believe that the use of the *ChemApp* can help them to achieve their intended grades for the chemistry course. Such results indicated that the use of *ChemApp* can help the learner to improve their learning. Similar findings are also reported in [39] who reviewed different studies that are related to mobile learning, spanning from 2008-2012, and found that more than 80% of the conducted studies related to students' learning achievements reported positive results.

TABLE III: LEARNER'S PERFORMANCE EVALUATION RESULT

Questions	Min	Max	Avg.	Std.
1. When I use ChemApp, my skills are enhanced.	3	5	4.33	0.31
2. I am sure that ChemApp increased my understanding of the chemistry.	2	5	4.36	0.34
3. Using ChemApp would enable me to perform learning tasks more quickly.	3	5	4.53	0.29
4. Using ChemApp will not help me to achieve my desired grade in the chemistry course.	1	5	1.70	0.69

Concerning Learner's Satisfaction, the answers of the three questions were positive (see Table IV). The majority of the pupils were satisfied with using *ChemApp* for the chemistry course and they liked the provided services by *ChemApp*. Also, they agreed on recommending the app to other peers. The answers on these questions can have a direct impact on their intension to use and perceived usefulness of the *ChemApp*. This is also mentioned in the literature [35], [40], [41].

TABLE IV: LEARNER'S SATISFACTION EVALUATION RESULT

Questions	Min	Max	Avg.	Std.
5. Generally, I am satisfied with ChemApp.	1	5	4.36	0.34
6. I liked the services provided to me by the app.	3	5	4.33	0.39
7. I will recommend ChemApp to classmates.	1	5	4.46	0.40

Table V shows the results related to Learner's Behavior. The rating of question 8, question 9 and question 10 were positive. This means that the majority of the pupils would like to use mobile learning in their learning process, and they would like to use it on a frequent basis. Also, they enjoyed using *ChemApp*.

On the other hand, the rating of question 11, which is related to the use of *ChemApp* anywhere, were neutral. This can be related to different factors such as learning independence [13].

TABLE V: LEARNER'S BEHAVIOR EVALUATION RESULT

Questions	Min	Max	Avg.	Std.
8. After I used ChemApp, I plan to use mobile learning applications as a part of my studies.	3	5	4.13	0.33
9. *I will not use ChemApp frequently in the lectures of the chemistry.*	2	5	2.03	0.53
10. I am enjoying using ChemApp.	2	5	4.63	0.32
11. I will not hesitate to start ChemApp anywhere; I will not only use it during lectures.	1	5	*3.83*	0.53

Concerning the questions related to Learners' Motivation, high average scores were obtained (see Table VI). The results for all related questions showed that the students are highly motivated to use *ChemApp*. As evidenced by the results on question 12, question 13, and question 15, pupils are willing to use *ChemApp* in the classroom different times and frequently. This shows that the pupils are motivated to apply the *ChemApp* application during traditional lectures. Such findings echo those reported in the literature which claim that m-learning can increase learners' motivation and improve their attitude [3]. However, some researchers [1], [42] attributed this effect to the so-called novelty effect and this means that the effect would only be temporally. In other words, once the student gets familiar with the use of mobile learning technology, the effect on his attitude and motivation might diminish. This was also concluded in a number of studies presented in [3].

TABLE VI: LEARNER'S MOTIVATION EVALUATION RESULT

Questions	Min	Max	Avg.	Std.
12. I like to use the ChemApp to learn as much as possible.	2	5	4.26	0.44
13. I want to use the ChemApp in traditional classroom facilities.	1	5	4.40	0.33
14. I believe that I cannot improve my skills by using the ChemApp.	1	3	1.46	0.51
15. I believe that using the ChemApp has helped me to learn more things I'm interested in.	1	5	4.36	0.45

Questions that are related to perceived usefulness were positively rated except for one question that was rated neutral. Tabel VII also revealed a number of findings. Question 19 ("Using such an m-learning application could make both teaching and learning easier") was rated with the highest average and lowest standard deviation. This can be considered as a good indication for the perceived usefulness of using m-learning technology in learning and teaching. The rest of the questions that received a positive score were question 16 ("Using ChemApp would improve my learning performance") and the negatively formulated question 18 ("*Using this app would not increase my productivity (i.e. reduce the time required to accomplish tasks*"). These results indicated that the pupils agreed with the idea that *ChemApp* can improve learner's performance, increase student's productivity, and make the learning and teaching process easier. This is also confirmed in [3]. Question 17 was given a neutral score with a relatively high standard deviation. This question was about the possibility of enhancing the academic achievement. Apparently, the pupils were not convinced that the app would improve their achievements. This finding needs more investigation by for instance comparing students' academic results before and after using m-learning applications.

TABLE VII: PERCEIVED USEFULNESS EVALUATION RESULT

Questions	Min	Max	Avg.	Std.
16. Using ChemApp would improve my learning performance.	1	5	4.56	0.37
17. ChemApp would enhance my academic effectiveness.	2	5	*3.86*	0.56
18. Using this app would not increase my productivity (i.e. reduce the time required to accomplish tasks).	1	4	1.96	0.69
19. Using such m-learning application could make both teaching and learning easier.	3	5	4.70	0.24

Usability was divided to three subcategories: content quality, layout and graphic design, and ease of use. The overall result for the usability of *ChemApp* showed good results. The Content Quality' questions, as well as the Layout and Graphic Design questions were all rated positively. Finally, ease of use was also rated positively except for one question that received a neutral a score In the next section, an explanation about each aspect of the usability is given.

Table VIII showed the results concerning the content quality of *ChemApp*. The majority of the pupils like the content of *ChemApp*, as evidenced by the positive results given to all questions that are related to the content quality. For instance, pupils agreed with the division and readability of *ChemApp's* content. Furthermore, they indicated that the audiovisual learning resources were informative and responding quickly during interaction. Finally, they were satisfied with the content presented inside *ChemApp*. Note that the importance of content quality in mobile applications was highlighted in the reviewed literature in [3]. For instance, visualization is quite interesting for learners specially when the content cannot be seed with the naked eye [7],[13].

TABLE VIII: CONTENT QUALITY EVALUATION RESULT

Questions	Min	Max	Avg.	Std.
20. I agree that the content of ChemApp is clearly described to the user.	3	5	4.63	0.25
21. I am satisfied with the content of ChemApp.	1	5	4.43	0.41
22. I agree that the division of content within the app is straightforward.	2	5	4.00	0.44
23. The content in the application is readable.	2	5	4.40	0.48
24. I agree that the division of content within ChemApp is easy to absorb.	3	5	4.56	0.28
25. The audiovisual content of ChemApp was informative.	2	5	4.16	0.47
26. the audiovisual content of ChemApp responded quickly.	3	5	4.63	0.25

Table IX showed that the three questions related to the layout and graphic design were rated positively. However, the statement ("*The GUI of the application is not familiar to the user*") was given a neutral score. This could be due to the fact that most of the pupils are not familiar with using m-learning applications in general. The importance of the layout and graphic design is also highlighted in a number of reviewed work presented in [20], [43], which mentioned that the layout and graphic design can avoid frustration and confusion. Also, it was mentioned that good layout and graphic design are required for making information resources easier to take up.

TABLE IX: LAYOUT AND GRAPHIC EVALUATION RESULT

Questions	Min	Max	Avg.	Std.
27. The app is adapted to mobile devices' screen sizes.	2	5	4.06	0.40
28. The GUI of the application is not familiar to the user.	1	5	*2.03*	0.51
29. I found the text and colors not clear.	3	5	1.30	0.51
30. I am unhappy with the design of ChemApp.	3	5	1.46	0.63

Concerning the ease of use aspect (see Table X), two questions received a good score while the other question was given a neutral score. The questions about the ease of navigation and the user friendliness received a good score. However, neutral was given to the ease of distinguishing the meaning of the different icons. This result is expected as knowing the meaning of the icons need more time. This issue can be solved by giving more training time or providing a manual that describes the different icons' meaning and functionality.

TABLE X: EASE OF USE EVALUATION RESULT

Questions	Min	Max	Avg.	Std.
31. I found navigating in the app easy.	2	5	4.30	0.41
32. Distinguishing the appropriate icons in the app to find the needed information was easy.	1	5	*3.86*	0.53
33. The application was user friendly.	3	5	4.13	0.28

IV. CONCLUSION

The research work aims at investigating the use of a new trend which is m-learning by students in elementary schools in Palestine. To do so, an educational mobile learning App was developed to be used in the context of chemistry course by pupils who were included in the usability evaluation.

Based on the obtained results for this conducted evaluation, it can be concluded that m-learning applications can be considered as useful, supplementary tools for teachers in elementary schools. The conducted evaluation can be added to the existing evidences for the potential of using m-learning apps in Palestinian elementary schools, especially in chemistry courses. The proposed m-learning application in this research work can help 13-14 years old pupils (8^{th} grade) to understand the atom, molecules, periodic table and possible interactions between the different chemical elements.

This research work has a number of limitations. For instance, measuring the influence of using mobile application on the learning process itself was out of this research's scope. Aspects related to the use of m-learning such as knowledge retention, acquired skills, cognitive load, etc. need to be examined in the future. Evaluating the effectiveness of the use of m-learning using pretest and posttests can do this. Another limitation is related to the fact that this research was conducted only in one school and in one class; the number of the participants was limited to 30. More evaluations are required including more schools, classes, and pupils.

A correlational research study will be conducted in the future to investigate relationships between the different aspects that have been studied in this research. For instance, we will investigate the relationship between the perceived usefulness and learner's motivation. Such a study is useful and important because it provides evidence of a relationship between the developed mobile application and pupils' perceived performance, satisfaction and behavior.

An interview with teachers will be conducted to investigate teachers' attitudes toward the use of the m-learning for chemistry courses. This intended evaluation will examine readiness, willingness, and perception of integrating mobile learning in teaching activities. Also here, the focus will be on elementary school in Palestine.

Since assessment is considered an important feature in mobile learning [3], future work is related to providing grades to the different exercises and quizzes that are already available in the app.

The grades should be saved in the students' profile and the teacher should be able to monitor them. Such functionality allows the teacher to monitor the students' progress. In addition, the app can point the student to the lessons that are related to exercises for which he has low results in order to review the material and find his mistakes.

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