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Establishing Interactions Between Learning Aid Types And Their Delivery Levels In Micro-Learning Environments Using Mobile Web At Imam Abdul Rahman Bin Faisal University

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Abstract:

The present study aims to recognize the best types of learning aids in micro-learning environments via mobile web and determine the best level that is appropriate for presenting these types, as well as examine the interaction between them, concerning their impact on learning programming skills with (C ++) language and its cognitive and performance aspects, as well as the usability of administrative information system students to use these environments.

The experimental design (2 × 2) is utilized. It contains two independent variables: First, learning aids type in micro-learning environments, and it has two types, (Continuous learning aids versus on-demand learning aids). Second: The delivery level of learning aids in the micro-learning environment, which includes two levels of aids, namely: (Brief aid versus detailed aid). The study included three dependent variables: Achievement related to the cognitive aspect of programming skills, performance rate, and the usability of the micro-learning environment via the mobile web. The research sample consists of (40) students from the third-level students, , College of sciences - Imam Abdul Rahman bin Faisal University. They were distributed into (4) groups. One-way, and two-way analysis of variance and Tukey's test are used to analyze the data. The results show that the on-demand aid type in micro-learning environments via mobile web is better than the continuous aid type and that the brief aid is better than the detailed aid. Furthermore, the best experimental treatment resulting from the interaction between the type and level of learning aid is for the treatment that uses brief learning aids on-demand.

Keywords: Learning aids, micro-learning, mobile web.

1. Introduction:

Nowadays, nearly all teachers struggle with presenting a large amount of content through lectures while attempting to cover all of the information they believe is important. As a result, the path gradually grows and sometimes becomes out of control, eventually affecting student performance.

According to Zufic (2015), the impact of information and communication technology increased effectively in education and learning at all levels of education. One of its most important modern forms is the emergence of the so-called micro-learning via the mobile web.
It is a learning that takes place in a short time and utilizes a focused educational approach based on performance (10 minutes at most), with accurate and rich video content with text, images and audio.

Omer Jomah et al (2016) explain that micro-learning is a novel way to respond to the need for work-based learning and personal development. It is regarded as more successful since it mixes modest content with technological flexibility.

According to Dejan Kovachev et al. (2016), all micro-learning applications may be found in e-learning, notably mobile learning. This is due to the importance of mobiles as one of the most essential learning tools that can be relied on in offering various educational services due to their widespread use, convenience of use, ability to access the Internet via it, and large storage capacity. Furthermore, it enables the reception of various applications that can be utilized in communication, support, and help activities.

Several studies have underlined the benefits of mobile micro-learning in skill development. Hasan Kadhem's (2017) study, for example, intends to use micro-learning based on mobile to improve student's retention of information technology concepts and related skills. The findings indicate remarkable development in the retention of information and abilities in this field. According to Randoll and Kali (2004), the concept of learning aids in this context refers to providing temporary support and guidance to the learner during the learning process in a way that assists him in completing new learning tasks and encourages him to develop knowledge himself, which the learner may not be able to do without this assistance.

Vodeclic (2015) states that numerous types of educational aids and support can be added to the micro-learning environment via the mobile web. The most crucial are continuous learning aids and on-demand learning aids, which are provided to the student via his mobile phone only at his request. As a result, the learner requests aid and advice based on his needs and desire for assistance and guidance.

When the researchers reviewed the literature on continuous and on-demand learning aids, they discovered a rarity in studies that are concerned with the mechanisms of organizing and providing both types of aids in micro-learning via mobile web, as most studies are concerned with support and assistance through educational software or the web. According to these findings, there is a preference for one style over another. Furthermore, some studies compare the efficiency of on-demand learning aids to continuous learning aids, such as:

Jackson et al. (2000) study, which emphasizes that on-demand learning aids in interactive multimedia computer programs work to meet individual differences between learners by providing unique aids.

Azevedo et al. (2005) study, which examined three types of learning aids (continuous-on-demand- and no-aid) in learning environments using hypermedia via the web. The study's

results reveal a significant positive impact of on-demand learning aids concerning their effect on mental models for learners.

Elbaz, Galal-Edeen & Gheith, (2011) identify that usability is considered a controversial issue in the field of interaction between humans and e-learning environments. More research is required to understand user behaviors of multimedia-based systems and environments, to assist designers and developers in creating natural, powerful, and suitable user interfaces. Among several techniques for designing that interaction and creating better and more convenient user interfaces, the user-centered design methodology is the most well-known. (p. 93).

Gonzalez & Granollers (2008) also pinpoint that usability is one of the most important features of mobile application-based micro-learning environments (p. 247).

2. Research Problem:

The research problem is realized through:

- The existence of obstacles for administrative information system students in mastering the practical aspect of the course, where learning is done traditionally, although there are individual differences between learners.

-Reviewing many studies by researchers that dealt with the effectiveness of microlearning environments, including (Coakley et al.; D. Roisin; G. Neill, 2017; Hasan Kadhem, 2017). These studies verified the effectiveness of the micro-learning environment in the development of a variety of outputs which include the performance aspect and the skills associated with learning.

- Although many researchers and studies, i.e., Dejan Kovachev et al. (2016) study, attempted to develop micro-learning environments by studying their variables and referring to learning aids as one of its components as mentioned previously, these studies did not illustrate the appropriate types of these aids and its relationship to the levels of delivery via micro-learning environments. The results of some researchers and studies related to the effectiveness of micro-learning environments that, according to Vodeclic (2015), not all learners can learn successfully in these environments. This necessitates the integration of these environments with support and electronic assistance to assist the learner on the right path to achieve the learning objectives.
- The present research problem then is represented in trying to determine the most appropriate type of interaction between learning aid patterns (continuous – on-demand) and their (brief-detailed) levels of delivery via micro-learning environments by indicating their impact on both the development of programming skills and usability among administrative information system students at Imam Abdul Rahman bin Faisal University.

In order to address this problem, the research attempts to answer the following main research question:

- What is the impact of developing the interaction between the types of learning aids and the levels of their delivery of micro-learning environments via the mobile web on developing the programming skills and usability of administrative information system students at Imam Abdul Rahman bin Faisal University?

From this main question emerged the following sub-questions:

- What is the impact of the interaction between learning aid types and the levels of their delivery in the micro-learning environments via the mobile web on the development of the cognitive and skillful aspects of programming in (C++) and the usability of these environments among administrative information system students?

- What are the standards for a micro-learning environment based on learning aids?
- What are the programming skills in the (C++) language included in the programming course for Administrative Information System second-year students at Imam Abdul Rahman bin Faisal University?
- What are the proposed design and educational development models for building a micro-learning environment via the mobile web for developing the cognitive and performance aspects of programming in the (C++) language?
- What is the impact of the difference in the level of providing (brief - detailed) learning aids in micro-learning environments via the mobile web on developing the cognitive and performance aspects of programming in (C++) and the usability of these environments for administrative information system students?

3. Objectives of the study

The current study aims at the following:

3.1 Preparing a list of programming skills in the (C++) language included in the programming course for third-level students in the college of scinces .

3.2 Determining the criteria for providing learning aids in micro-learning environments.

3.3 Identifying the most appropriate type of learning aids (continuous-on-demand) in micro-learning environments in developing the cognitive and performance aspects of programming skills in (C++) language, and improving the usability of these environments.

3.4 Identifying the most appropriate level of (brief - detailed) learning aid in micro-learning environments in developing the cognitive and performance aspects of programming skills in (C++) , and improving the usability of these environments.

3.5 Identifying the most appropriate form of interaction between learning aids types (continuous aids - on-demand aids) and the levels of providing them (brief aids - detailed aids) in micro-learning environments in developing the cognitive and performance aspects of programming skills in (C++) language, and improving the usability of these environments.

4. The importance of the study

The importance of the current study for the researchers lies in the following:

a- Directing those in charge of the educational process and the field of administrative information systems to enhance the utilization of the potential of micro-learning environments in overcoming the obstacles facing administrative information system students in studying some courses.

b- Directing the interest of researchers in the field of administrative information systems towards some structural variables of micro-learning environments, considering these environments as one of the innovations that should be studied, and knowing the ways to benefit from them.

The importance of the current study for society lies in the following:

a- The concerned educational institutions are adopted to integrate micro-learning activities into the daily routine tasks of the learner, through the technological means of the mobile web that would facilitate the learning process for students and thus develop community learning methods. b- Directing those in charge of the educational process and the field of administrative information systems to adopt new strategies and tools for designing electronic microlearning environments to raise the level of various learning outcomes that will contribute to the advancement of society.

c- Providing the designers and developers of the micro-learning environment with a set of principles and scientific foundations when designing these environments that are related to the types of learning aids and the levels of their delivery to develop the entire educational process.

5. Limitation of the study:

The study is limited to the following:

- **Objective determinants:** cognitive and performance aspects of programming skills in (C++) language.
- **Human determinants:** The course was taught to third-level.
- **Spatial determinants:** College of Sciences , Imam Abdul Rahman bin Faisal University
- **Time limits:** The research was applied in the first semester of the 2021-2022 academic year.
- **Research variables**: The research includes the following variables:

- **Independent variables:**

a. Types of learning aids in micro-learning environments.
b. Levels of providing learning aids in micro-learning environment

- **Dependent variables:** The study included the following dependent variables:

a. Cognitive aspects of programming skills in (C++) language
b. The performance aspects of (C++) programming skills.
c. Usability.

6. The Research Experiment and its tools

The researchers adopt the quasi-experimental approach to study the impact of the interaction between the types of learning aids and the levels of their delivery in microlearning environments on developing programming skills and their usability among administrative information system students.

6.1. Research Experimental Design:

In light of the research methodology and its variables, the experimental design of the research is based on the (2 × 2) design. Accordingly, four experimental groups are formed, on which the research tools are pre-applied, to ensure homogeneity among the students. Then, experimental treatment is conducted and their scores are compared in the post-application to determine the significant differences resulting from treatment and the extent of the interaction between types of learning aids in micro-learning environments and their delivery levels on the dependent variables.

Table 1. Experimental designs and groups

Learning aid types (fixed- variable)	Learning aids delivery levels	
	Brief	**Detailed**
Continuous	Group No. (1) used a brief continuous learning aids	Group No. (2) used detailed continuous learning aids
On-demand	Group No. (3) used a brief on-demand learning aid	Group No. (4) used detailed on-demand learning aids

6.2. Measurement tools

- Achievement test to measure the cognitive aspect of programming skills. (Prepared by the two researchers)
- A test to measure the performance aspect of programming skills. (Prepared by the two researchers)
- Usability scale of the micro-learning environment. (Prepared by the two researchers)

7. Hypothesis

7.1 There is no statistically significant difference at the ≤ 0.05 level between the average grades of experimental groups students in the achievement test to measure the cognitive aspect associated with programming skills due to the fundamental impact of the different types of (continuous/on-demand) learning aids in micro-learning environments.

7.2 There is no statistically significant difference at the ≤ 0.05 level between the average grades of experimental groups students in the achievement test to measure the cognitive aspect associated with programming skills due to the fundamental impact of the different levels of (brief/detailed) learning aids in micro-learning environments.

7.3 There is no statistically significant difference at the ≤ 0.05 level between the average grades of experimental groups students in the achievement test to measure the cognitive aspect associated with programming skills when studying via the microlearning environment due to the fundamental impact of the interaction between (continuous/on-demand) learning aids types and their delivery levels (brief/detailed).

7.4 There is no statistically significant difference at the ≤ 0.05 level between the average grades of experimental groups' students in the programming skills performance test (C++) language due to the fundamental impact of the different learning aids types (continuous/on-demand) in micro-learning environments.

7.5 There is no statistically significant difference at the ≤ 0.05 level between the average grades of experimental groups' students in the programming skills performance test (C++) language due to the fundamental impact of the different levels of providing (brief/detailed) learning aids in micro-learning environments.

7.6 There is no statistically significant difference at the ≤ 0.05 level between the average grades of experimental groups' students in the programming skills performance test (C++) language due to the fundamental impact of the interaction between learning aids types (continuous/on-demand) and their delivery levels (brief/detailed).

7.7 There is no statistically significant difference at the ≤ 0.05 level between the average grades of experimental groups' students in the usability scale of the micro-learning environment due to the fundamental impact of the different learning aids types (continuous/on-demand).

7.8 There is no statistically significant difference at the ≤ 0.05 level between the average grades of experimental groups' students in the usability scale of the micro-learning environment due to the fundamental impact of the different levels of providing (continuous/ on-demand) learning aids.

7.9 There is no statistically significant difference at the ≤ 0.05 level between the average grades of experimental groups' students in the usability scale of the micro-learning environment due to the fundamental impact between (continuous/on-demand) learning aids types and their delivery levels (brief/detailed).

8. Research procedures

To perform the research procedures, the researchers take the following steps:

8.1 Conducting an analytical survey of the scientific literature and studies related to the research topic to prepare the theoretical framework for the research.

8.2 Analyzing and arbitrating programming skills in (C++) language to ensure the correctness and completeness of the analysis.

8.3 Analyzing the standards of the micro-learning environment based on learning aids.

8.4 Preparing the achievement test for the cognitive aspect of programming skills, arbitrating it, and putting it in its final form.

8.5 Preparing and arbitrating the performance test for programming skills in (C++) language, in addition to putting it in its final form.

8.6 Preparing and arbitrating the usability scale of the micro-learning environment in addition to putting it in its final form.

8.7 Producing experimental treatment materials.

8.8 Conducting an exploratory experiment for experimental treatment materials.

8.9 Applying pre-measurement tools to calculate achievement degrees and skill performance rates.

8.10 Presenting the experimental treatment materials to the sample members according to the experimental design of the research.

8.11 Applying post-measurement tools: applying the achievement test, the skill performance test, and the usability scale on the same sample members.

8.12 Conducting statistical treatment of results, analyzing data, and calculating the extent of change in students 'achievement, their skill performance rate, and their usability of these environments, and comparing application results in light of the theoretical framework, related literature and theories.

8.13 Presenting recommendations for future research in light of the results that have been reached.

9. Research Terms

Learning aids: Yayan (2007) defines it as "The temporary aid needed by the learner during the process of building knowledge, which is removed when construction is completed and becomes able to support itself."

Micro-learning: Job (2012) defines it as " a small piece of digital information, which is often a single piece of information of specific length and time, depends on the interaction between learners and the Internet, and helps to sort and provide information with knowledge of the learning context of the learner."

Mobile Web: DeJan Kovachev et al (2016) define it as developing new ways of learning and acquiring knowledge through the combination of mobile technologies and Web 2.0 applications.

10. Theoretical framework

The theoretical framework of the current study is divided into the main axes as follows:

The first axis: Micro-learning via mobile web

The second axis: The learning aids

The third axis: Developing programming skills via (C++) language

The fourth axis: The usability and its relation with learning aids and their delivery levels in the micro-learning environment.

First: Micro-learning via mobile web

Recently, mobile technologies and web applications have managed to develop new methods of learning and acquiring knowledge. Students use Web 2.0 platforms, such as the free encyclopedia (Wikipedia) and microblogs, as a result of the increase in the number of official study materials. In addition, the emergence of smart mobile applications and mobile Internet has made it easier to obtain content anywhere and anytime. The current convergence of the web and mobile platforms and programs has led to the emergence of informal methods of learning, such as micro-learning. According to DeJan Kovachev et al (2016), microlearning refers to the design of activities with accompanying content in its small format using digital media.

Hug (2015) pinpoints that the concept of micro-learning refers to providing a group of resources that are comfortable and easy to use when dealing with them, to cover knowledge gaps and create an individual who can understand Internet resources and find an integrative relationship between micro-content and learning activities and using them in the daily life.

Job (2012) defines it as micro-content consisting of small pieces of digital information, which is often a single piece of information of specific length and time that depends on the interaction between learners and the Internet and helps to sort and provide information with knowledge of the learning context of the learner.

Some concepts associated with micro-learning:

Jomah et al (2016) study deal with some concepts associated with micro-learning, including:

Microcontent: It is a small unit that has very limited digital information. It is very important and attractive as it is treated individually in comparison with the traditional content. It is permanent, free, separate content, and suitable for viewing on mobile devices.

Social web programs: These programs represent a major feature to support social interaction, as individuals with different interests and different prior knowledge are gathered through social networks based on cooperation. Besides, micro-learning can be supported by social programs, because it allows the rapid exchange of content in short and flexible pieces.

Principles of designing and using micro-learning via the mobile web:

The design of micro-learning is based on several bases and principles, illustrated by Nicole (2012) in the following points:

- Determining one goal for learning, as creating a course with Micro-learning requires distinguishing one goal.
- It is preferable to rely on the YouTube website, which is visited by a large number of people daily, weekly, and even monthly.
- The length of the video clip shall not be more than (10 minutes).
- The focus shall be on the main concept and the additional content shall be omitted.
- Getting feedback
- Fast micro-content creation and easy access to it

Accordingly, some studies have attempted to employ and use some of these technologies in micro-learning environments and to measure their impact on the development of some learning outcomes and results, including Despina Kamilali & Chryssa Sofianopoulou (2015) study that aimed at integrating the use of micro-learning and mobile learning in open-source electronic group lessons. This is to take a new learning approach, provide microlearning and its components over mobile, and use it in huge open online courses. The study concluded that the integration between the use of micro-learning and mobile learning in open-source electronic group lessons is effective and possible.

Second: The learning aids

Alessi and Trolip (2001) identify two types of learning aids that are needed by the learner in multimedia programs:

Procedural aids: They are the aids for operating and using the program and knowing the icons. It is always available. It is provided in the form of instructions at the beginning of the program and it is obtained at any time by pressing the help button.

Information aids: They are the aids for teaching the content to obtain more details or additional examples. These aids must be clear, easy, simple, and appropriate for the learner (p. 77).

In this regard also Boticki et al (2011) classify learning aids through mobile web applications into two types as follows:

Continuous aids: Through these aids, the learner is supported with additional information and content by stable timetables related to the topics studied by the learner in the traditional environment. This aid is transmitted via the mobile web applications to the learner regardless of whether or not he requests this aid. It is the responsibility of the teacher or the educational developer to determine the content of the necessary aid for the learner.

On-demand aids: They are called adaptive or flexible aids, and they are provided only to the learner according to his or her needs, as the educational aid is transmitted to the learner via mobile web applications only when the learner requests. Also, the responsibility for determining the content of the aids falls on the learner.

The current research will utilize the (continuous - on-demand) aid types in micro-learning environments via mobile web applications.

Some studies aimed at comparing continuous and on-demand aids, such as Azevedo et al (2005) study which presents three situations related to learner aid (continuous aid - on-demand aid - no aid) in the learning environment in hypermedia. The results of the study reveal a significant positive impact of flexible aids (on-demand) about its impact on the mental models of learners.

The importance of learning aids in micro-learning environments via the mobile web: Some believe that the effectiveness of educational attitudes and programs is measured by the amount of help and support they provide to the learner in the educational environment, as they develop the skills and abilities of the learner in addition to providing him with confidence to make his decisions. Therefore, the learning aids that are provided in microlearning environments via various mobile web applications and tools provide many educational opportunities for learners, including:

- Receiving information and details on the subject of learning
- Sharing ideas with other learners
- Improving interactions between teachers and learners
- Providing valuable opportunities for immediate learning
- Supporting learner-centered learning processes, and
- facilitating participatory learning processes through simultaneous and asynchronous communication (DeJan Kovachev et al. 2016)

Tools and applications for providing learning aids in micro-learning environments: It can be said that the tools for providing learning aids in micro-learning environments via the mobile

web are based on two main axes: devices and applications. As for the first axis, which is devices, the learning aid tools depend on a variety of devices such as mobile phones, iPad ... but the most widespread in the range of devices is mobile phones, where it can provide many services, including mobile communication through social applications, making calls, sending SMS's, multimedia messages, playing multimedia files, and playing educational games (DeJan Kovachev et al. 2016).
As for the second axis, which is applications, Hasan Kadhem (2017) pinpoints that there are many mobile web applications available such as video-sharing applications (YouTube), microblogging applications (Twitter), social networking applications (Facebook), and Whats App applications and many other applications.

Third: Developing programming skills via (C++) **language What is a programming skill:**
A programming language is defined as "the language used in writing a set of commands and instructions, through which the learner can inform the computer of the tasks required of it to be performed."

The skill is also known as "the intended practice that is well-organized to accomplish a job with maximum accuracy, speed, mastery, and the least amount of effort, time, as well as accuracy, skill, and efficiency in performing a series of subsequent steps.

In the current study, the programming skill is also defined as the learner's ability to write the codes for programming projects in the VB.net language, in a condition that it shall be written with a high degree of speed, accuracy, mastery, and innovation by using VB.NET program.

Stages of learning programming skills by (C++) **language**
Programming skills learning is generally carried out in three basic stages: knowledge stage, installation stage, and self-control stage. In this research, the stages of learning and developing programming skills by (C++) language are done through the following stages:
1. The stage of acquaintance with programming skills in the (C++) language that is covered by the research. It is summarized in the learner's acquaintance with the general objectives of the course, in addition to the procedural objectives of each educational element within the content submitted to him or her. 2. The stage of the learner's observation of the skill practically via the micro-learning environment.

3. The stage of creating dialogue, discussion, and assisting learners by using tools and mobile web applications through the micro-learning environment, to discuss the difficulties they face when learning the skill.
4. The starting stage of the learner's practice of skill practically, recording the steps of skill performance and mistakes that he has failed in and then providing instant feedback to the learner, or by electronically recording and sending this feedback to him.
5. The stage of correcting the mistakes that the learner has made by allowing him to retry the skill while giving him time to learn it.
6. The stage of full mastery of programming skills in (C++) language with saving time and effort.

Measuring skills and assessing them
(C++) programming skills are measured in the current research from two aspects:

1. The cognitive aspect of the skill: It relates to cognitive achievement and is measured by utilizing an achievement test

2. The performance aspect of the skill: in which the learner's performance for the steps that lead to (writing the code for specific programs) is measured by a performance test to measure the performance aspect of the skills.

The fourth axis: The usability and its relation with learning aids and their delivery

Ease of use is essential for the use of any electronic learning environment, as clarity, simplicity, and focus on the unity of the subject are necessary characteristics associated with the ease of use of any system. Accordingly, the importance of usability appears in the user's ability to access the scientific material or satisfy his actual needs on the system. If the user fails to reach what he desires, he may leave the system forever, in search of another system that fulfills the conditions of simplicity, clarity, and ability to access faster and easier to the scientific material that he wants to obtain (Nielsen, 2007.p5).

The usability of electronic learning environments is characterized by a set of characteristics, identified by Nokelainen (2006, pp. 196-197) and Hee Kim and Ho Kim (2008, p. 868) in several points as follows:

- Effectively: it means the system's ability to achieve the goals and bring about the required learning.
- Efficiency: It means the system's ability to achieve the goals with the required speed and with the fewest errors.
- User properties: it means that the system is designed to suit the user's characteristics, in a way that achieves comfort and satisfaction for him.
- Ease of Learning: This means that the system is characterized by ease and helps the user to complete the required tasks.
- Satisfaction: that is, the user feels comfortable, satisfied, and enjoyable when using the system.
- Memorability: It refers to how easy it is for the user to recall the information after some time, and to remember how to complete the required tasks while using the system after a period of use. The ability to remember is measured by the number of errors that the user makes while completing the task after learning how to accomplish the mission.
- Clearness & Simplicity: It means that the system is designed to be clear and simple by focusing on the unity of the subject so that it can be used well.
- Learnability: It refers to the ease with which the user can accomplish the tasks required of him through dealing with the system, and the learning ability is measured by the time spent in completing and achieving the required tasks, the number of errors during the completion of the task and therefore the learning ability has a relation with designing an interface to the system.

In the current study, the researchers found a clear relationship between the types of learning aids in micro-learning environments and the usability of these environments. These learning aids have a basic impact in enabling the educational designer to prepare an educational environment that is clear and logical in presenting information and helps learners to understand and practice information in new educational situations.

Within the literature that focused on the relationship between the design of e-learning, micro-learning environments, and usability, The Van and Ling (2008) study, indicates that there is an impact between the design of website screens and the usability on the ease of navigation of the learner and the speed of his or her learning.

11. Research Methodology

Since this research is quasi-experimental, the researchers have taken the following procedures:

11.1 First: Research methodology and its variables The researchers use the following:

1. **Descriptive and analytical approach:** for preparing a list of design standards in micro-learning environments via mobile web-based learning aids.
2. **The quasi-experimental approach:** to study the causal relationship between the independent and dependent variables.

11.2 Second: The research sample

The research sample consists of (40) students from the third level . They are distributed into four groups, each group consisting of (10) students. The first group (uses brief continuous learning aids); the second group (uses detailed continuous learning aids); the third group (uses brief learning aids on-demand) and the fourth group (uses detailed learning aids on-demand).

11.3 Third: A list of standards for designing a micro-learning environment based on learning aids has been prepared.

11.4 Fourth: Designing and developing experimental treatments

11.4.1The Analysis Stage

The analysis stage is divided into the following:

11.4.1.1 Determining goals and assessing needs.

11.4.1.2 Learner characteristics analysis:

The learners' characteristics are analyzed according to two main axes as follows:

The first axis: Using mobile web applications

The second axis: The input behavior of learners concerning some learning outcomes.

11.4.1.3 The analysis of educational assignments: In this step, the educational content of the programming course topics for the third-level students in the college of sciences is analyzed. This is to determine the cognitive and performance aspects of VB.Net programming skills and to find the ultimate cognitive and performance skills.

11.4.1.4 Analyzing resources and constraints in the educational environment: The researchers have developed a micro-learning environment that is the subject of the current study in light of the skills they have in the design and development process.

11.4.2 The designing stage

This stage includes designing the following:

- Designing educational goals
- Designing learning aids
- Designing tools for providing learning aids in a micro-learning environment via mobile
  The researchers have used some of the applications available through the students' mobile phones, which include designing the following tools:

- **Course topics**

- **Assisting tools**
- The delivery of assistance, whether continuous or on-demand, depends on a specific set of applications and tools for the mobile web in the micro-learning environment, as follows:

Table 2. tools for the mobile web in the micro-learning environment

S. No.	Tool
1	**SMS messages** Mobile messaging applications are used to send urgent aids and notes that students should pay attention to when practicing programming skills via VB.Net. The researchers use the publisher program for mobile learning
2	**Whats app service** It is used to open a simultaneous and asynchronous text discussion environment to support learners with urgent content
3	**Microblogging Twitter** It is used to raise urgent and important aid related to programming course topics
4	**Google due** It is used to make simultaneous communications with students to provide them with needed assistance

11.4.2.1 Determination of teaching and learning methods and strategies: The researchers identify a set of strategies that could be applied across the micro-learning environment for teaching the content of the programming course in the VB.net language. The researchers use the strategy of combining presentation and discovery, as it combines teacher presentation with learners' discoveries.

11.4.2.2 Design of the Educational Interaction Strategies Scenario: In the light of current research treatments that have been designed, the nature of educational interactions based on the learner's interaction with peers, assistance content, and teacher, is determined in the context of individual, collaborative and participatory interactions in small groups.

11.4.2.3 Designing the general education strategy:

The overall strategy of micro-learning education is based on stimulating motivation and willingness to learn by using methods of attracting and directing attention using tools and mobile web applications.

11.4.2.4 Choosing multiple learning resources:

The mobile web applications and tools have been chosen to provide this aid, depending on a group of digital objects that are related to the learning content.

11.4.3 Development stage:

This stage included the following steps:

- Preparing designs for digital content. □ Production Planning
- Actual development (production)

11.4.4 The initial evaluation stage of the micro-learning environment and making adjustments

- The formative evaluation process: through which the validation of the micro-learning environments (experimental treatment materials) is valid for use and their suitability to achieve the desired goals.
- Finishing process and the final output: After completing the formative evaluation processes for the micro-learning environments via the mobile web, the learning aids in the micro-learning environment are prepared in their final form.

12- Research tools

1. **The cognitive aspect test of programming skills in** (C++) **language:** An electronic cognitive achievement test is prepared and designed in light of the educational content to measure the cognitive aspects related to programming skills in (C++) language, and this process has gone through the following stages:

a. **Identifying the type of the test and its terms:** The achievement test terms are formulated in the form of (true and false, and multiple choice)

b. **Preparing a table of specifications for the test**: the relative weights of the educational subjects are determined, as well as identifying the relative weights of cognitive levels (remembering, comprehension, application, and analysis), as well as determining the number of questions that are related to each topic.

Table 3. specifications for the cognitive achievement test

Main educational topics	Total behavioral goals	Cognitive goals				Total topic questions	Relative weights for goals and questions
		Remembering	Comprehension	Application	Analysis		
The first topic If … Then	10	5	3	1	1	10	37.04 %
The second topic If … Then … Else	3	1	1	-	1	3	11.11 %
The third topic If … Then … Else If	11	2	5	1	3	11	40.74 %
The fourth topic Select … Case	3	2	-	-	1	3	11.11 %
Total	27	10	9	2	6	27	100%
Relative weight		37.04 %	33.33 %	7.4 %	22.23%		

c. **Measuring the validity of the cognitive achievement test:** It is meant by the validity of the test, the test's ability to measure what it is used for and to measure the validity of the cognitive achievement test. The test is prepared in its initial form and it consists of (35) questions; (20) questions of the type of true and false, and (15) questions of the type of multiple-choice. The test is presented in its initial form to the arbitrators, and after taking the opinions of the arbitrators With all adjustments made, the test became final, consisting of (27) questions; (20) questions of the type of true and false, and (7) questions of the multiple-choice type.

d. **Grade estimation and correction method:** one grade is evaluated for each item that the learner answered correctly, and zero for each item that he left or answered incorrectly.
e. **Test stability calculation:** To calculate the stability of the test, the test was applied to an exploratory sample other than the main research sample, and to ensure the internal stability of the test (intrinsic coherence), the Cronbach (α) factor is calculated using the SPSS statistical processors program, to show the extent to which the test vocabulary is related to each other, as well as the correlation of each item with the test as a whole, which is also called the internal consistency of the test. Besides, the reliability coefficient is equal to (0.85), which is a reliability coefficient indicating that the test has a high degree of reliability.

2. Performance test of programming skills in (C++)**:**

The process of preparing the performance test for programming skills in (C++) in the current study goes through the following steps:

a. Identifying the performances of programming skills in (C++) language: The performance test is prepared in its final form as it includes (12) skills that branched into (110) phrases describing the actions required of the learner in each performance step to include the different performance aspects of the skill. The skills are arranged in a consistent order.

The following table shows the weighted value in degrees for each step of the skill performance.

Table 4. The weighted value in degrees for each step of the skill performance

S. No	The main skills	Number of sub-skills	Number of steps	Weighted value in scores
1	If…Then phrase	4	26	26
2	If…Then…Else phrase	2	18	18
3	If…Then…ElseIf phrase	5	56	56
4	Select …Case phrase	1	10	10
	Total	12	110	110

b. **Setting up a performance test score rating system:** The performance test is set electronically, by setting a score for the performance that is performed correctly and zero for the performance that is not performed completely or that is performed incorrectly.
c. **The validity of the performance test:** To verify the validity of the performance test, it was presented to a group of arbitrators and experts in the field of administrative information system.
d. **Performance test reliability calculation:** The performance test reliability factor is calculated in a multi-evaluator method on the performance of a single learner by applying to an exploratory sample, then calculating the agreement factor between their estimates using the Cooper formula, where the two researchers, in co-operation with two faculty staff members, evaluate the performance of the skills of (10) students. The percentage of agreement among the evaluators for each learner is calculated using the (cooper) formula. The average agreement of the evaluators is equal to (88.12%), which is considered a high-reliability rate. As a result, the performance test is valid for use, and it is applied to the research sample as a measurement tool.

3. The scale of usability of the micro-learning environment: The scale was prepared according to the following steps:

a. **Identifying the sources for deriving the measure.**
b. **The initial image of the scale for the usability of the micro-learning environment via the mobile web:** The usability scale is prepared and designed, as the scale includes in its initial form (8) dimensions, and (5) levels were defined to estimate the usability of the micro-learning environment from the learner's point of view for all areas of the scale according to the following gradient:

Strongly Agree Agree Neutral (not sure) Not agree Strongly not agree
5 4 3 2 1

c. **The validity of the scale:** To verify the validity of the scale, it was presented to a group of arbitrators and experts in the field of administrative information system.
d. **Scale reliability:** It is calculated by calculating the Cronbach "alpha" factor (α) using SPSS to indicate the extent of the scale's vocabulary correlation with each other, as well as the correlation of each item with the scale as a whole, which is also called the internal consistency of the scale. The reliability factor is equal to (0.93), which indicates that the scale has a high degree of reliability and usable
e. **The final scale:** After confirming the validity and reliability of the scale, it became in its final form of (8) dimensions. It included in its final form (30) paragraphs with a total score of (150).

The main research experiment :

The main research experiment has gone through the following steps:

13.1 Pre-application:

The two measurement tools were pre-applied to the research sample on Sunday (04/11/2019) and by comparing the average scores of the experimental group students in each of the two measurement tools, where the One Way Analysis of Variance is applied to identify its significant differences between groups in the scores of the cognitive test and the pre-test of skill performance.

Table (5) shows the results of the one-way analysis of variance for the four groups, to ensure that groups have equal access to the cognitive and performance aspects of the skill.

Table 5. The significance of the differences between groups in the pre-measurement to test cognitive achievement and skill performance to verify the equivalence of the experimental groups

Dependent variable	The source of variance	Sum of squares	Degree of freedom	Square average	(F) value	Function level	Significance at ≥ 0.05
The cognitive aspect of achievement	Between groups	1.38	3	0.461	0.3160	0.813	Not significant
	In groups	81.600	56	1.457			
	Total	82.983	59				
Skill performance	Between groups	0.396	3	0.132	00.208	0.891	Not significant

rate	**In groups**	35.515	56	0.634			
	Total	35.910	59				

The two values of (F) in the previous table indicate that there are no statistically significant differences at the level of ≥ 0.05 between the averages of the pre-application scores of the four research groups. Accordingly, the groups can be considered equivalent before the experiment is conducted. Besides, any differences that appear after the experiment are due to the two independent variables under the current study. Hence, the Two-way analysis of variance method will be used for each dependent variable separately.

13.2 Implementation of the research experiment:

The research experiment was carried out according to the following steps:

- Introduction to the research experiment, where a session is held with the research sample students, to familiarize them with the nature of the research, its objectives, and what is required of them.
- Each group shall know that it has a specific continuous or on-demand aid type that is provided according to a brief or detailed level.
- The research sample students are directed to study the content of the programming course through the micro-learning environment according to the task schedule that is implemented in the classrooms.
- The researchers direct the educational aids to the research sample students and form the various digital objects through the micro-learning environment according to the experimental treatments of the research.

13.3 The post-application of the research tools

The post-application of the research is carried out according to the following steps:

- After completing the research experiment, the cognitive achievement test, the skill performance test, and the usability scale are applied to the research sample.
- After completing the application of the post-tools, the scores report for all students is printed and monitored, in preparation for dealing with them statistically. **14- Research results, discussion and interpretation:**

14.1 The answer to research questions related to cognitive achievement:

These questions are answered according to the sequence of presentation of the hypotheses that are formulated for the research variables, and Table (6) indicates the results of this analysis.

Table 6. Averages and standard deviations for achieving the cognitive side of programming skills in VB.Net

Group			
Brief on-demand learning aids	25.1000	1.19722	251.00
Detailed on-demand learning aids	20.6000	1.50555	206.00
Detailed continuous learning aids	20.3000	1.63639	203.00

Brief continuous learning aids	21.9000	1.91195	219.00
Total	21.975	2.45459	879.00

Table (6) shows the results of the descriptive statistics of the four groups regarding the achievement of the cognitive aspect related to programming skills, and it is noticed from the data presented in the table that there is a clear difference between the average degrees of earning for the types of learning aids (continuous and on-demand) and their delivery level in the micro-learning environment (brief and Detailed).

14.2 Presentation and interpretation of the results of the evidentiary findings of the cognitive achievement of the programming skills:

The following table shows the results of the two-way analysis regarding the cognitive achievement of programming skills.

Table 7. Results of two-way analysis of variance on the cognitive achievement of programming skills

Variance source	Sum of the squares	Freedom degree	Average of the squares	F value	Significance level
Learning aids types	30.625	1	30.625	12.209	.001
Learning aids levels	93.025	1	93.025	37.086	.000
The interaction between types of learning aids and levels of delivery	21.025	1	21.025	8.382	.006
Wrong	90.300	36	2.508		
Total	19551.000	40			

By using the results of Table (7), the results can be reviewed in terms of the impact of the two independent variables of the research and the interaction between them in light of the discussion of the first three hypotheses of the current study, which are as follows:

14.2.1 Results of the first hypothesis:

By extrapolating the results in Table (8) , it is clear that there is a statistically significant difference between the averages of the scores of the cognitive achievement of programming skills, as a result of the difference in the patterns of learning aids in the micro-learning environment. In order to identify the direction of the differences, the Tukey equation is applied to show the direction of the differences .This is because the sample numbers are equal.

Table 8. Results of the Tukey equation to reveal the direction of differences between the achievement test averages

Learning aids types	Averages	continuous	On-demand

Continuous learning aids	21.1000	—	
On-demand learning aids	22.8500	Significant	—

The previous table shows that there is significance in favor of the higher average, for the experimental group that used learning aids on demand. Thus the first hypothesis is rejected.
The value of the impact size of the independent variable is (13%) in terms of ETA squared, concerning its effect on the achievement of the cognitive aspect of programming skills. This result indicates that the students who studied through the learning aids among the students are more positive in the achievement of the cognitive aspect of the skill compared to the students who studied through the continuous learning aid. Accordingly, this result should be taken into account when designing micro-learning environments via the mobile web, especially if this finding is supported by the results of future studies and research.

The results of this study are in agreement with the results of Azevedo, R. et al (2004) study, as the results of this study indicate that the learners perform better by using the flexible support type on-demand. The results of the study differ from the Zainab Al-Salami (2008) study, which indicates the equal impact of a reliable and flexible support pattern on achievement.

14.2.2 Results of the second hypothesis:

By extrapolating the results in Table (9) it is clear that there is a statistically significant difference between the averages of the degrees of gain in the cognitive achievement of programming skills, as a result of the difference in the level of delivery of learning aid. To identify the direction of these differences, the Tukey equation is applied to show the direction of differences in groups.

Table 9. Tuki equation results to detect the differences between achievement test averages as a function of the level of provision of learning aid

Learning aids delivery level	Averages	Brief	Detailed
Brief aids	23.5000	—	Significant
Detailed aids	20.4500		—

The previous table shows that there is significance in favor of the group with the highest average, which is the brief aid level group (23.5000), while the group that used detailed aid has an average of (20.4500). Accordingly, the second hypothesis is rejected.
The value of the effect size according to the eta squared equation (.396). This result indicates the presence of an average effect size between the independent variable and the dependent variable, which is the cognitive achievement of programming skills. This means that the level of brief learning aid has an effective impact on the achievement of the cognitive aspect of the skill. This result indicates that a brief learning aid has a statistically significant positive impact on cognitive achievement compared to a detailed learning aid.

14.2.3 Results of the third hypothesis:

By extrapolating the results in Table (10), it is clear that there are statistically significant differences at the level of ≤ 0.05 between the averages of the scores of gain in achievement

related to the cognitive aspect of programming skills as a result of the interaction between the types of learning aids and the levels of their delivery. To determine the direction of these differences, the Tukey equation is applied to demonstrate the direction of differences in groups.

Table 10. Results of the Tukey equation to reveal the direction of differences between the achievement test averages

Type of interaction	Average	On-demand learning aids - Brief	On-demand learning aids - Detailed	Continuous learning aids - Brief	Continuous learning aids - Brief
On-demand learning aids - Brief	25.100	––	Significant	Significant	Significant
On-demand learning aids - Detailed	20.600	Significant	–		
Continuous learning aids - Brief	21.900	Significant		–	
Continuous learning aids - Detailed	20.300	Significant			–

This result illustrates that the students who used the brief aid on-demand are more positive in achieving the cognitive side of programming skills. Accordingly, the hypothesis is rejected. The size of the effect by the eta squared equation is (584.), which is also an average ratio of the interaction of the independent variable and its impact on the dependent variable, which is programming skills. These results are consistent with the results of Marwa Zaki's (2013) study, which indicates the effectiveness of flexible support on-demand in developing knowledge related to preparing scientific research plans skills.

14.3: Presentation and interpretation of the results of programming skills in VB.NET language:

These questions are answered according to the sequence of presentation of the hypotheses that are formulated for the research variables, where the results of the four groups are analyzed concerning the average skill performance of the students of the research sample, concerning the averages and standard deviations, and according to the variables of the current study.

Table 11. illustrates the results of this analysis.

Group			
Brief on-demand learning aids	103.8000	2.35938	993.00

Detailed on-demand learning aids	103.4000	1.71270	1034.00
Detailed continuous learning aids	99.000	1.63639	1033.00
Brief continuous learning aids	103.3000	2.78089	1038.00
Total	102.4500	2.79147	4098.00

Table (11) shows the results of the descriptive statistics of the four groups for the average performance of programming skills, and it is noticed from the data presented in the table that there is a clear difference between the average earning scores for the types of learning aids (continuous - and upon request) and the levels of their presentation in the micro-learning environment (brief - detailed)

14.4 Presentation and interpretation of the significant results of the average performance of programming skills:

The following table shows the results of the two-way analysis regarding the average skill performance of programming skills in the VB NET language.

Table (12): Results of two-way analysis of variance for the average performance of programming skills

Variance source	The sum of the squares	Freedom degree	Square average	F value	Significant level
Learning aid types	48.400	1	48.400	10.237	.003
Learning aid level	32.400	1	32.400	6.853	.013
The interaction between learning aid types and their delivery level	52.900	1	52.900	11.189	.002
Wrong	170.200	36	4.728		
total	420144.000	40			

By using the results of Table (12), the results can be reviewed in terms of the impact of the two independent variables of the study and the interaction between them, in light of the discussion of the hypotheses from the fourth hypothesis to the sixth hypothesis of the current study, which are as follows:

14.4.1 Results of the fourth hypothesis:

By extrapolating the results in Table (12), it becomes clear that there is a statistically significant difference between the average gaining scores in the rate of programming skills performance, as a result of the difference in learning aid types in the micro-learning environment. To identify the direction of the differences, the Tukey equation is applied to show the direction of the differences, as the sample number is equal.

Table (13): Results of the Tukey equation to show differences in direction between the average skill performance scores

Learning aid types	Averages	Continuous	On-demand
Continuous learning aids	101.150	__	
On-demand learning aids	103.6000	Significant	__

The previous table shows that there is significance in favor of the higher average, for the experimental group that uses learning aids on-demand. Thus the fourth hypothesis is rejected. The value of the effect size of the independent variable is (.159) in terms of eta squared, concerning its effect on the skill performance of programming skills. This result is consistent with much of the literature that referred to the effectiveness of learning aids on demand in developing the skills of learners, such as Marwa Zaki Tawfiq's (2013) study.

14.4.2 Results of the fifth hypothesis:

By extrapolating the results in Table (13) in the second line, it becomes clear that there is a statistically significant difference between the average scores in the programming skills performance rate as a result of the difference in the level of learning aids in the microlearning environment. To identify the direction of the differences, the Tukey equation is applied to show the direction of the differences, as the sample number is equal.

Table 14. Results of the Tukey equation to show differences in direction between the average skill performance scores

Learning aid types	Averages	Continuous	On-demand
Continuous learning aids	103.550		
On-demand learning aids	101.200		

The previous table shows that there is significance in favor of the higher average, for the experimental group that used the brief learning aid. Thus, the fifth hypothesis is rejected. Also, the value of the effect size of the independent variable was (.159) in terms of eta squared, concerning its impact on the skill performance of programming skills.

This result is consistent with the principles of the Reinforcement Theory, which believes that the directions for performing the skill should be divided into small, brief, and focused instructions. These small instructions are associated with every step of the learner's performance, and this is what the brief learning aids in the micro-learning environment try to provide to students on their demand. For any help related to VB.NET programming skills.

14.4.3 Results of the sixth hypothesis:

By extrapolating the results in Table (13) in the third line, it is clear that there are statistically significant differences at the level of ≤ 0.05 between the averages of gaining scores in the programming skills performance rate, as a result of the interaction between the types of learning aids and the levels of their delivery. To identify the direction of these differences, the Tukey equation is applied to show the direction of differences in groups.

Table 15. Results of the Tukey equation to show differences in direction between the average skill performance scores

Type of interaction	Average	On-demand learning aids - Brief	On-demand learning aids - Detailed	Continuous learning aids - Brief	Continuous learning aids - Brief
On-demand learning aids - Brief	103.8000	-–	Significant	Significant	Significant
On-demand learning aids - Detailed	103.4000	Significant	–		
Continuous learning aids - Brief	99.000	Significant		–	
Continuous learning aids - Detailed	103.3000	Significant			–

This result illustrates that students who used brief aid on-demand are more excellent in programming skills performance rate. Accordingly, this hypothesis is rejected. The size of the effect was reached by the eta squared equation (.46), which is also an average ratio of the interaction of the two independent variables and their impact on the dependent variable, which is programming skills.

14.4 Displaying the results of the usability scale for the micro-learning environment:

These questions are answered according to the sequence of displaying the hypotheses that are formulated for the research variables, where the results of the four groups are analyzed concerning the usability scale of the micro-learning environment of the research sample students, for the averages and standard deviations, and according to the two variables of the current study. Table (16) illustrates the results of this analysis.

Table 16. Averages and standard deviations of students' usability in micro-learning environment

Group	Average	Standard deviation	Total
Brief on-demand learning aids	145.5000	3.80789	1455.00
detailed on-demand learning aids	143.6000	3.53396	1436.00
Detailed continuous learning aids	135.9000	3.44642	1409.00

brief continuous learning aids	140.9000	4.25441	1359.00
Total	141.4750	5.14900	5659.00

Table (16) shows the results of the descriptive statistics of the four groups regarding the scale of usability for the micro-learning environment, and it is noticed from the data presented in the table that there is a clear difference between the average scores of usability between the two types of learning aids (continuous and on-demand) and the levels of their delivery in the micro-learning environment (brief - detailed).

It is also noted from the data presented in the table that there is a clear direction towards learning aids on-demand in the micro-learning environment, as well as a clear tendency towards the level of brief aid.

Presentation and interpretation of the evidentiary results of the usability scale for the micro-learning environment. The following table illustrates the results of the two-way analysis concerning the usability scale for the micro-learning environment

Table 17. Results of the two-way variance analysis of the usability scale for the micro-learning environment

Variance source	The sum of the squares	Freedom degree	Average of the squares	F value	Significance level
Learning aids types	378.225	1	378.225	26.558	.000
Learning aids levels	119.025	1	119.025	8.358	.006
The interaction between types of learning aids and levels of delivery	24.025	1	24.025	1.687	.202 Not significant
Wrong	512.700	36	14.242		
Total	801641.000	40			

By using the results of Table (17), the results can be reviewed in terms of the impact of the two independent variables for the research and the interaction between them in light of the discussion of the hypotheses from the seventh to the ninth of the current research, which is as follows:

14.4.1 Results of the seventh hypothesis:

By extrapolating the results in Table (17), it is clear that there is a statistically significant difference between the averages of the scores of usability, as a result of the difference in the types of learning aids. To identify the direction of the difference, the Tukey equation is applied, as in the following table:

Table 18. Results of the Tukey equation to reveal the direction of differences between the averages of the usability scale

Types of learning aids	Averages	Continuous	On-demand
Continuous learning aids	138.400	__	
On-demand learning aids	144.400	Significant	___

The previous table shows that there is significance in favor of the higher average, which is on-demand learning aid, where its average is (144,400), while the average of continuous learning aid is (138,400). Thus, the seventh hypothesis is rejected. The value of the effect size is (.366) according to the eta squared equation, which indicates the presence of average effect size for the first independent variable concerning its impact on the usability of micro-learning environments, which indicates the strength of the treatment effect.

14.4.2 Results of the eighth hypothesis:

By extrapolating the results in Table (18) in the second line, it is clear that there is a statistically significant difference between the average score of usability, as a result of the difference in the level of the learning aid. To identify the direction of the difference, the Tukey equation is applied, as in the following table:

Table 19. Results of the Tukey equation to reveal the direction of differences between the averages of the usability scale

Learning aids level	Averages	Brief	Detailed
Brief learning aids	143.2000	__	significant
Detailed learning aids	139.7500		__

The previous table shows that there is significance in favor of the higher average, which is the group of the level of brief learning aid, as its average is (143.2000), while the average of the detailed aid is (139.7500). Thus the eighth hypothesis is rejected. According to the eta squared equation, the value of the effect size is (.155) This indicates the presence of average effect size for the second independent variable regarding its impact on the usability of micro-learning environments, which indicates the strength of the treatment effect. This result is consistent with both Ramadan Heshmat's (2017) and Walid Youssef's (2014) studies. The results of this study differ from Amira Al-Moatasim and Muhammad Attiyah's (2010) and Marwa Muhammad's (2016) studies.

14.4.3 Results of the ninth hypothesis:

By extrapolating the results in Table (19), it is clear that there are no statistically significant differences at the level ≤ 0.05 between the averages of usability scores as a result of the interaction between the type of learning aid and the levels of its delivery in the microlearning environment. Thus, the null hypothesis is accepted.

15 .Research recommendations and suggestions

- From the results that have been reached, the present study can draw the following recommendations and suggestions:

- Taking advantage of prior studies and research that investigated the impact of some variables in developing and producing micro-learning environments on the various learning outcomes when planning and producing these environments.
- Using mobile web applications in micro-learning environments to meet a variety of educational needs.
- The current study deals with a sample of administrative information system students, so it is possible to change the research sample or choose some students with special needs when employing the types of learning aids in the micro-learning environment.
- Addressing research that provides answers on the potential of micro-learning environments in improving the technological and educational abilities and material required to integrate electronic educational games in the classroom. It is noteworthy that empirical research often includes a short period, and this requires adopting the approach of repeated research. Accordingly, the current research recommends the necessity of re-conducting the current research by researchers on different study subjects as a prerequisite for generalization.

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