The Impact of the Interactive Mobile Learning Environment on Developing the Adaptive Multimedia Production Skills of Instructional Technology Students

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The Impact of the Interactive M- Learning Environment on Developing the Adaptive Multimedia Production Skills of Instructional Technology Students

Abstract:

The aim of the current research is to develop an interactive M-learning environment and reveal its impact on the development of adaptive multimedia production skills for students of the fourth year, Instruction Technology Dept., Faculty of Specific Education, Minia University in the second semester of the academic year (2020/ 2021 AD). The research followed the experimental method, and the semi-experimental design The experimental design with two groups: the experimental group consisting of (30) students who studied in an interactive m-learning environment, and the control group consisting of (30) students who studied in the traditional method, in order to develop the skills of multimedia production. The adaptive media and the measurement tools, namely: the cognitive test and the multimedia assessment card, and the results showed a difference between the scores of the experimental group and the control group in the cognitive and performance aspect of the adaptive multimedia production skills.

Keywords: Interactive M- Learning Environment, Adaptive Hypermedia.

أثر بيئة التعلم التفاعلي في تنمية مهارات إنتاج الوسائط المتعددة التكيفية لطلاب تكنولوجيا التعليم

المستخلص:

هدف البحث الحالي إلى بناء بيئة تعلم تفاعلية نقالة، والكشف عن أثرها في تنمية مهارات إنتاج الوسائط المتعددة التكيفية لطلاب الفرقة الرابعة، شعبة تكنولوجيا التعليم، كلية التربية النوعية، جامعة المنيا في الفصل الثاني من العام الجامعي 2020/ 2021م. واتبع البحث المنهج التجريبي، والتصميم شبه التجريبي بمجموعتين: التجريبية مكونة من (30) طالبًا وطالبة درسوا في بيئة تعلم تفاعلية متنقلة، والضابطة مكونة من (30) طالبًا درسوا بالطريقة التقليدية، وذلك بهدف تنمية مهارات إنتاج الوسائط المتعددة التكيفية. وتمثلت أدوات القياس في: الاختبار المعرفي، وبطاقة تقييم مهارات إنتاج الوسائط المتعددة التكيفية. وأظهرت النتائج فاعلية بيئة التعلم التفاعلية النقالة، وتفوق طلاب المجموعة التجريبية على نظرائهم طلاب المجموعة الضابطة في الجانب المعرفي وأداء مهارات إنتاج الوسائط المتعددة التكيفية.

الكلمات المفتاحية: بيئة تعلم تفاعلية نقالة، الوسائط المتعددة التكيفية.

Introduction:

The current era is known as the era of technological and knowledge explosion. It is also known as the era of information technology. Therefore, it is necessary to keep pace with this technological development, coexist with it and use it in various areas of life, especially in the teaching and learning process to reach and achieve the desired goals. Therefore, it is important to search for educational methods and methods that contribute to providing learners with knowledge in its various forms, adapting them to knowledge according to their learning methods and methods of providing content to them, navigating through the content, and giving them the skills that qualify them to coexist in an interactive technological environment, and develop mental skills and the ability to learn, and perhaps One of the most important skills necessary for learners is to provide them with interactive mobile learning technology.

Marković, M. G., Kadoić, N., & Kovačić, B. (2018). and Steichen, B., Ashman, H., & Wade, V. (2012, 699) that with the recent trend towards providing adaptive learning environments, there has been a growing interest in the field of adaptive hypermedia, where learners are able to adapt content according to the presentation model The method of navigation and navigation, in accordance with the standards on which adaptive learning environments are built. It is one of the modern methods and technologies that have emerged in this field and focused on adapting multimedia according to the changing needs of users, in addition to changing content, forms, backgrounds and contexts in order to provide personalized responses that correspond to the needs of each learner. Adaptive hyper modes allow for linear and non-linear navigation according to goals, preferences and context.

Indicates (El Guabassi, I.2018; Marwan El-Mohammadi, 2016; Mampadi, F& et al, 2011; Retalis, S., & Papasalouros, A., 2005) have known adaptive manifolds, and the most important points can be extracted from the definition is:

1. Adaptive hypermedia consists of two main parts: adaptive presentation; It means adapting the presentation of the content of a page by adapting the presentation of texts or adapting the presentation of multimedia. Secondly, the

methods of adaptive navigation, which means adapting and changing the form of links that appear to the learner within the course according to his objectives, learning style, and level of knowledge.

2. The term adaptation relates to the conditional change of the sequence of presentation of learning materials during the learning activity on the basis of the previous interaction of the learner as well as according to the type of learner previously defined.
3. Designing educational materials on the basis of pedagogical rules, which combine the content model, the user model, and educational strategies.

The adaptive hypermedia is primarily concerned with the way in which information is presented that suits each user's learning style, taking into account what he has of his experiences, his preferred learning media, and the goals he seeks to achieve, as these media allow the learner to choose the content that he wants. He wants to learn it, and it also helps him choose the methods of displaying the content, and provides him with navigation tools that enable him to navigate inside the content, and exit at any time (Rabee Raymod, Wael Abdel Hamid, 2014, 56).

A study (Yang, P., Ni, R., Zhao, Y., & Zhao, W. 2017) indicated that content adaptation occurs through changes in learning elements such as images and content. There are four ways to adapt; the first is shape adaptation by hiding, showing, or adding effects to the binary image data. The second type of adaptation is the line or letter adaptation, through which words or a letter of the words are hidden, shown or changed or its color changes. The third type of adaptation is the size by changing the size of the word by zooming in or out, the fourth and final style is image scaling, in which images are enlarged or reduced, or converted from two-dimensional images to three-dimensional images. Displaying content in its various forms (text, video, images, ect.).

While adaptive navigation refers to the set of links in the user interface, so that it helps the learner to access the information he wants, and the importance of navigation comes as a means through which bridges are built between the parts of the digital

content, which relates to the extent to which the learner can know his current position in the content, and how Methods for the appearance and concealment of links must also be taken into consideration when designing adaptive hypermedia To follow through links, adaptive navigation is a tool that helps the learner to reach what he wants. (Mohamed Khamis, 2013 .

The study (El Guabassi, I, et al, 2018) indicated the possibility of integrating adaptive content into a pervasive or mobile learning environment, by allowing physical, virtual and logical sensors to obtain learner information, determine the appropriate learner style, and defines content presentation methods that suit each learner .

As demonstrated by the study of Zuel, B. (2017). The effectiveness of the adaptive multimedia on undergraduate students of astronomy in an electronic learning environment, where the study aimed to reveal the effectiveness of the adaptive multimedia. Multimedia.

The study (Carolan, S, et al, 2015) also focused on how to design adaptive hypermedia environments in engineering sciences, where it relied on developing educational content to suit the needs of heterogeneous learners, and educational materials are increasingly built on the semantic web. The study recommended the necessity of employing the capabilities of the Semantic Web when building or developing adaptive hypermedia content.

The study of Özyurt, Ö.,etal, 2012)) designed an adaptive hypermedia system based on learning styles, and supported by an expert system. Learning style, and the study recommended the necessity of integrating adaptive learning environments into the real learning environment, and measuring its impact on learners' academic achievements.

It is clear from the above that traditional educational systems that use hypermedia, or multimedia, provide all learners with the same educational content, which contains the same links, which sometimes leads to the learner’s loss. Hence, adaptive hypermedia systems appeared to solve this problem by providing content adapted to Course objectives and learning style, and in this context, the importance of sufficient multimedia appears, as evidenced by the presentation of the related studies, the

emergence of the need for more scientific studies concerned with the study of adaptive multimedia and how to produce and develop them in proportion to the characteristics of the learners due to their importance in the educational process and its role Basically it is done in adaptive learning environments.

The knowledge society in which learners of this age live, needs flexible learning environments that facilitate learners to communicate and interact through various learning strategies, and despite the needs of the knowledge society, most traditional forms of learning are no longer suitable to keep pace with social learning processes and meet learning requirements. Educational institutions are quickly directed to employ mobile learning, which will support learners and activate flexible learning processes, which are important matters.

The great development in information technologies and the increase in the use of electronic devices led to the emergence of a new term in the field of education called mobile learning or mobile learning. It has been defined by Kim, HJ, Lee, JM, & Rha, JY (2017) and Muhammad Al-Omari (2014) as a form of distance learning through the use of small, hand-held wireless devices such as mobile phones, and PDAS. Smart phones, and Tablet PCs, to achieve flexibility and interaction in the teaching and learning process anytime and anywhere.

One of the reasons that called for the necessity of using mobile learning in educational processes is the increasing growth of mobile devices, and the multiplicity of services provided by those devices that can be employed in the field of education. Another reason is the spread of distance learning patterns and the community's need for it, and it contributes to solving the problem of limited education and helps all groups of society to learn (Crompton, H., Burke, D., & Gregory, K. H. (2017)

The study (Suárez, Á.,etal.2018) aimed to identify the types of activities that depend on mobile learning, and support students through mobile learning technology, and the results showed the effectiveness of the activities provided through mobile learning. The study (Christensen, R., & Knezek, G. 2017) was also concerned with the readiness to integrate mobile learning into the classroom, and the readiness for mobile learning is a new aspect

of the technological integration of teachers within the educational process. In addition to identifying the best educational strategies in a mobile learning environment, teachers should also be supportive of mobile learning through their professional development to foster enthusiasm and desire to integrate mobile learning into the educational process

Feeling the problem:

The sense of the research problem stemmed from several sources, including:

- The field of educational technology is one of the fields that need to keep pace with technological innovations and employ their programs and applications. To develop the educational process and achieve its goals, adaptive multimedia is one of the innovations that requires training an educational technology specialist to employ and use it in teaching and learning, according to (Carolan, S, 2015; Hazra, AK, Patnaik, P., & Suar, D.2013; Kulaglic, S..2013) on the importance of employing adaptive multimedia in education, which contributes significantly to the development of the educational process.
- There is a need to train students of the Education Technology Division on the production of adaptive multimedia in education, and this was shown by the results of the exploratory study that was applied to a sample of educational technology students, where the results showed that (85%) of them did not know the meaning of adaptive multimedia, and (90%) Of them, they do not have knowledge of adaptive multimedia production skills, and the exploratory study of the applied side showed that (92%) do not have the skill of showing or hiding texts based on the learner's response, and that (95%) do not have the skill of enlarging or reducing the text, and (97%) do not have the skill to show or hide existing links.
- Learning Content: The emergence of the importance of mobile learning as an educational environment characterized by flexibility, speed, participation and continuous interaction between learners and the teacher, and considering the mobile learning environment is the

most suitable for providing adaptive multimedia production skills, in addition to providing an interactive mobile learning environment based on interactive applications such as interactive video, and some Android applications.

- The Eighth International Conference on Mobile Learning, held from 27-30 August 2017, in Cyprus, addressed the importance of using and employing mobile learning environments, as well as how to make learning more adaptive. Students can increase metacognitive awareness, improve their understanding and develop high communication efficiency by integrating mobile technology. As well as the Scientific Forum for Educational Technology held from December 17-18, 2017, in Cairo, which emphasized the importance of employing mobile learning in the educational process.
- Also, in response to the recommendations of Arab studies and research that dealt with the variables of the educational design of the mobile learning environment, one of the motives behind conducting the current research, including: Muhammad Al-Jabsi (2017), Moeen Khabar (2017), Nasser Youssef (2014), and studies that dealt with the variables of the educational design of this environment, including : Muhammad Khalaf Allah (2017), Khaled Al-Khayat (2016), Ahmed Muhammad (2016), and Jamal Al-Sharqawi (2012), both of which did not address the variables of instructional design of educational activities.

Research problem:

Based on the foregoing and procedurally, it is possible to determine the problem of the current research in the lack of adaptive multimedia production skills, and to reveal the effectiveness of an interactive mobile learning environment in terms of its impact on both the cognitive achievement and the performance aspect of the adaptive multimedia production skills, among students of educational technology; In order to address this problem, the current research attempts to answer the main question: What is the impact of an interactive mobile learning environment on the development of adaptive multimedia production skills among educational technology students?

The following sub-questions emerge from this question:

What is the impact of an interactive mobile learning environment for educational technology students on:

- Developing the cognitive side of adaptive hypermedia production skills؟
- Developing the cognitive side of adaptive hypermedia production skills.

Research objective:

The aim of the current research is to discover:

The impact of an interactive mobile learning environment on the development of

- Cognitive aspect of adaptive hypermedia production skill
- The skill side of adaptive hypermedia production skills.

The importance of research:

The importance of the current research has been given to both the learner and the instructional institution:

The current research derives its importance from the following:

- Links the research variables to the interactive mobile learning environment, which is an environment that needs further research and studies to address and study the design, development and use variables of it.
- Providing those in charge of educational design of educational environments with scientific and research results related to the interactive mobile learning environment.
- It may benefit researchers as it provides tools that can be used as a measure of absorptive thinking when preparing research.

Search limits:

The current search was confined to:

1. **Human limits:** The research is limited to a sample of fourth year students, Department of Educational Technology, due to their lack of knowledge and skills, as well as in response to the requirements of the labor market.
2. **Content limits:** The research is limited to the skills of adaptive hypermedia production, and these skills are

represented in - First, content adaptation skills, which are (insert or delete parts of the content, change part of the content, darken part of the content, arrange parts of the content, enlarge or reduce part of the content) Second: adaptive content presentation skills (text, images, animations , audio, video clips) Third: Adaptive navigation skills (showing links, arranging links, hiding links) due to the lack of these skills among students of educational technology

3. **Temporal limits**: The research experiment was applied in the second semester of the academic year (2020 / 2021).
4. **Spatial Limit:** The Internet (easy class M-Learning Environment) and the Scientific Research Laboratory in the Department of Education Technology at the Faculty of Quality Education, University of Minia

Research Methodology:

The current research is based on the development of an interactive mobile learning environment; Therefore, the descriptive approach was used in the phase of study, analysis and design of the learning environment and the experimental treatment material represented in the interactive mobile learning environment, and the quasi-experimental approach when measuring the impact of the independent variable on the dependent variables: (Adaptive Multimedia Production Skills) in the evaluation stage.

Research variables:

The search included the following variables:

1. The independent variable is an interactive mobile learning environment.
2. Dependent variables: adaptive hypermedia production skills.

Experimental design:

The experimental design 1×2 was chosen for the two research groups where the research tools were applied to them after conducting the experiment to compare the results of the post-application of the achievement test and the evaluation card, to determine the significance of the differences between the two groups, and to measure the size of the effect resulting from the

application of the experiment.

Research hypotheses:

In light of the research problem and its objectives, the researcher developed the following hypotheses to answer the questions of the current research, which are as follows:

1. There is no statistically significant difference at the level of ≤ (0.05) between the mean scores of the students of the experimental and control groups, in an interactive mobile learning environment, in the cognitive aspect of adaptive multimedia production skills.
2. There is no statistically significant difference at the level of ≤ (0.05) between the mean scores of the students of the experimental and control groups, in an interactive mobile learning environment, in the cognitive aspect of adaptive multimedia production skills

The research sample:

A sample of the Third year students, Department of Instructional Technology, Faculty of Specific Education, Minia University, consisting of (60) male and female students, and (30) male and female students for the exploratory experience.

Research tool:

The following tools are used:

First: Data collection tools, which consisted of a questionnaire to determine the most important adaptive multimedia skills.

Second: The experimental processing tool represented in an interactive mobile learning environment, which is the "moodle learning environment" through which the skills of adaptive hypermedia production are presented in different forms. The skills are presented in the form of interactive videos, interactive infographics, interactive flash clips, or interactive simulations, and it also includes an environment Mobile learning is a set of interactive activities.

Third: Measurement tools:

1. An achievement test for adaptive hypermedia production skills "prepared by the researcher."
2. Product evaluation card for adaptive hypermedia production skills "prepared by the researcher

Research terms:

After reviewing the previous research and literature, procedural concepts for the search terms were reached as follows:

- Procedurally interactive mobile learning environment is defined as: a wireless electronic learning environment "Moodle" that is provided to fourth grade students on their mobile devices such as mobile phones, personal digital assistants (PDAs), smart phones, and tablet pcs. Through this environment, content is provided Interactive learning for adaptive hypermedia and this content is in the form of interactive videos, interactive infographics, interactive flash clips to achieve flexibility and interaction in the teaching and learning process anytime and anywhere.
- Adaptive Hypermedia: defined (Yaghmaie&Bahreininrjad.2011) user (learner) systems and concept models, providing the teacher with copies of final personal information about each user, and helping to create and generate a unique learning experience for each learner, on a baseline basis. Knowledge of the learner, objectives, and learning style.
- Adaptive multimedia production skills can be defined procedurally: a set of skills that are presented to students of the fourth year in the Department of Educational Technology, which are divided into skills of displaying adaptive content, skills of navigating within adaptive content, and these skills are produced through the Adobe Flash cc program and these skills are measured by an achievement test For the knowledge side of these skills, and a product score card for these skills.

Theoretical framework and previous studies:

The interactive mobile learning environment and adaptive hypermedia e-learning environments are characterized by the spirit of group and integration between individuals to accomplish what has been assigned to them, and this makes them more effective and develops social skills among students. (Eman El shrief, 2021,9 (1) ،99-230)

M- learning

Mobile devices have spread at an unprecedented rate in the past decade and 95% of the global population live in an area covered by a mobile-cellular network (ITU, 2016). Device ownership has exploded with the majority of adults owning more than one mobile device (Statista, 2016). The largest demographic of mobile device users is 18–29 year olds (Pew, 2017; Poushter, 2016) which is also the typical age of college attendees. Recent empirical evidence indicates that mobile learning can be used to support students' learning in higher education settings (Ke & Hsu, 2015; Wu, Wu, Chen, Kao, Kin & Huang, 2012).

However, research in mobile learning has been fragmented and idiosyncratic and based on the understanding of the individual researcher (Alrasheedi, Capretz, & Raza, 2015). Pimmer, Mateescu, and Grohbiel (2016), report "after more than 20 years of mobile learning research, there is still relatively little systematic knowledge available, especially regarding the use of mobile technology in higher education settings" (p. 492). Therefore, the purpose of this systematic review is to provide the scholarly community with a current synthesis of mobile learning research in higher education settings.

Mobile Learning is a term to denote learning involving the use of a mobile device. The term is fully defined as "learning across multiple contexts, through social and content interactions, using personal electronic devices" (Crompton, 2013a, p. 4.). This definition provides insight to the educational affordances of learning with mobile devices, as learning is untethered, happening across contexts, time, subjects, people, and technologies (Crompton, 2013a; Laurillard, 2007; Traxler, 2010). Mobile devices, such as mobile phones and tablets, have a prompt off/on button and are easily portable, (Crompton, 2013b), following this definition, laptops were excluded from this study.

Several reviews of mobile learning have been conducted across the past ten years. Each contributed important information for scholars to better understand the use of mobile devices in educational settings. Some of these reviews were research that did not identify the educational setting in which the studies took place. The researchers reported their findings without describing the educational level of the learners. Frohberg, Goth, and Schwabe

(2009) conducted a review of 102 mobile learning projects to analyze the context, tools, control, communication, subject and objective of each study. Wingkvist and Ericsson (2011) reviewed 114 papers from the World Conference on Mobile Learning (mLearn) focusing on reserch purposes and methods.

Some reviewers have focused exclusively on k-12 educational settings. Liu et al. (2014) reviewed k-12 mobile learning articles from 2007 to 2012, investigating academic areas, research purposes, methods and outcomes. Crompton, Burke, & Gregory (2017) reviewed 113 studies which took place in pk-12 settings, investigating research purposes, methods, and outcomes. In addition, they investigated subject matter domains, educational levels and contexts, types of mobile devices, geographic distribution and learning theories.

Some researchers have specifically identified multiple educational settings in their reviews. Hwang and Tsai (2011) reviewed K-12, higher education and adult learner mobile learning articles from 2001 to 2010. They reported subject areas, grade level, and countries where the studies took place. Wu et al. (2012) reviewed K-12, higher education and adult learner mobile learning articles from 2003 to 2010. They investigated research purposes, methods, outcomes. Sung, Chang, and Liu (2016) analyzed 110 studies published from 1993 to 2013 which took place in k-12, higher ed and adult settings. They investigated the overall effect of using mobile devices in education. Chee, Yahaya, Ibrahim and Hassan (2017) reviewed 114 articles in k-12 and higher ed settings investigating longitudinal trends from 2010 to 2015.

All of these studies add to the scholarly understanding on the use of mobile learning across all grades and subjects. However, it is not easy to parse out what is specifically happening in higher education to understand how the devices are supporting learners in those settings.

A few researchers (viz., Alrasheedi et al., 2015; Kaliisa & Picard, 2017; Pimmer et al., 2016) have conducted more granular reviews with a focus on higher education. However, these reviews narrowed the focus further to only cover certain aspects of higher

education. Alrasheedi et al. (2015) studied critical factors that impact mobile learning implementation. Using Rogers' diffusion of innovations theory (Rogers, 2003), Alrasheedi et al. (2015) reviewed 30 studies from 2005 to 2013. Their analysis identified 14 critical factors which strongly impact mobile learning implementation. Their findings showed that the most critical factor for success was whether or not students perceived that their productivity was increased by using mobile learning. They also found that students were fairly satisfied with the usage of mobile learning in their courses and were interested in using mobile learning in the future.

Pimmer et al. (2016) analyzed 36 studies from 2000 to 2013 to uncover how mobile learning is used in higher education in relation to existing learning theories. Their research indicated that instructionism, rooted in the concept of behaviorism, was the most prevalent educational design. Kaliisa and Picard (2017) conducted a study examining various characteristics, such as type of device, instructor's and student's perceptions, methodologies, and theoretical frameworks. This study was narrow in focus as it only included studies conducted in Africa. All of these studies are valuable; however, they only show limited aspects of mobile learning in higher education.

Adaptive educational hypermedia

The domain of AEH concerns the personalisation of learning content presentation by adapting it to the learner's needs (Mulwa et al., 2010). AEH is based on hypermedia, adaptive systems, and Intelligent Tutoring System (ITS) (Brusilovsky, 2004); models and algorithms are often simpler compared to ITS (Cristea and de Mooij, 2003).

While this particular research focuses on sequencing of content, many other parameters can be adapted, for example colour, layout, language, and sorting (Knutov et al., 2009).

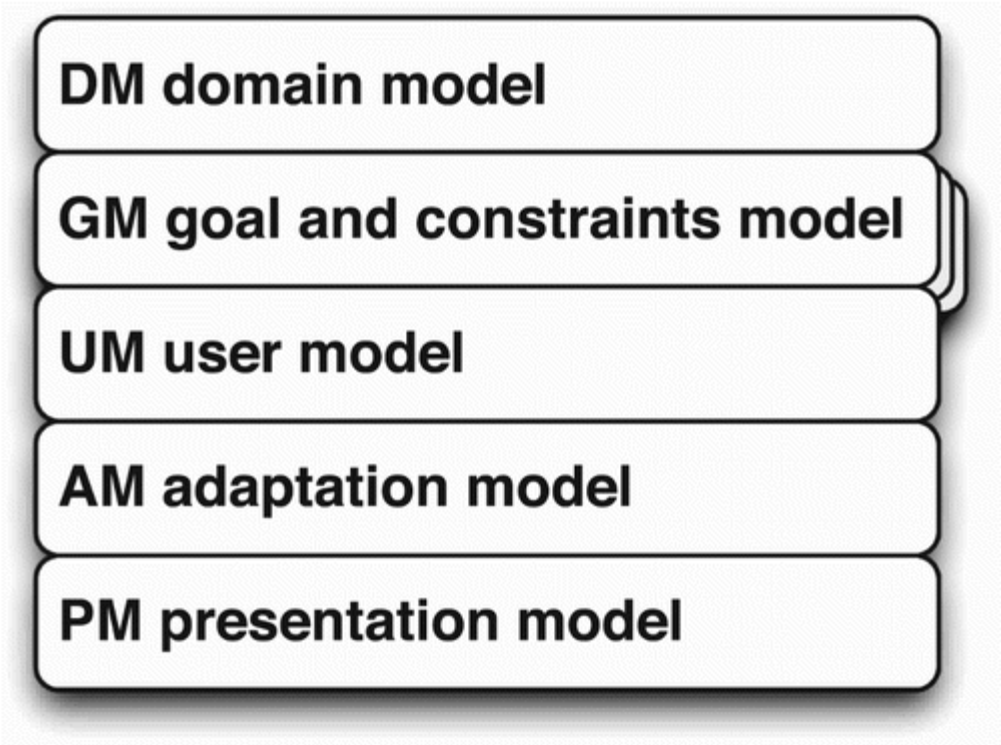
The underlying models for AEHS developed from hard coded models and content to reference models. First single-purpose systems had originally been developed for AEHS that used hard-coded models and content. It was difficult or even impossible to apply these systems to other content or different

domains, because the concepts and the models were too specialised. Thus, reference models were developed as second-generation AEHS-models. The Dexter model (Halasz and Schwartz, 1994) is the best known example. It consists of three layers: the runtime layer, the storage layer, and the within-component layer. In 1999, Adaptive Hypermedia Application Model (AHAM) superseded the storage layer with three models: the teaching model, the domain model, and the user model (Bra, Houbent, and Wu, 1999). Hence, AHAM consists of five models, which is the current state of art:

A typical architecture of the state of the art of AEHS is fully decoupled and consists of five complementary models: (i) The domain model which specifies what is to be adapted (ii) The user and context models which indicate what parameters the content can be adapted and (iii) the instructional and adaptation models which express the pedagogical approach the learning process should be based on, as well as the forms of adaptation to be performed. (Mulwa et al., 2010)

Because this research is about authoring adaptive learning content and structures, models that were designed with the authoring process in mind are of special interest. In the beginning, three layers were used: the conceptual layer, the lesson layer, and the student adaptation and presentation layer (Cristea and Aroyo, 2002). However, five layers were soon introduced: domain model, goal (and constraints) model, user model, adaptation model, and presentation model (Cristea and de Mooij, 2003), see Figure 1.

Figure 1. The layers of the five level AHS authoring model. This figure focuses on the layers only, discussion of the complete model can be found in (Cristea and de Mooij, 2003).



2.1. The current state of authoring adaptive educational hypermedia

Layering is important to separate the content from various abstraction layers. Thus, a mixture of different strategies can be used to adapt a presentation. It is thus easier to reuse content and structure because potentially only the strategies of the relevant layers need to be defined but not the content itself. However, authors find this definition task difficult: Firstly, authors who are unfamiliar with creating adaptive content structures are not used to thinking in layers: "when creating a course authors do not mentally distinguish between topic relations and pedagogical relations" (Bra et al., 2012). Second, authors who are not technically minded seem to be unfamiliar to creating generic content: "authors often start out by thinking in terms of a sequence or learning path instead of leaving as much navigational freedom as possible in their course and only using prerequisites where really needed" (Bra et al., 2012). These aspects still need to be addressed.

Additionally, authoring of adaptive content is very labour-intensive and therefore expensive (Razzaq and Heffernan, 2010). For example, at least one person working six months full time (Bra et al., 2012) is required to build an adaptive online module from a 1 European Credit Transfer and Accumulation System (ECTS) module (this 1 ECTS represents 25–30 h of study time). Reasons can be found in the architectural design that fails to meet the overall needs of Web-enhanced learning (Meccawy, Blanchfield, Ashman, Brailsford, and Moore, 2008) and the poor usability because of the prototypical implementation (Brusilovsky, Wade, and Conlan, 2007). Hence, it is very unlikely that educators are "willing to invest the significant time and effort required to initially integrate an AEHS into their teaching plans and to ensure that the learning offerings provided meet the curriculum." (Mulwa et al., 2010) Reusage of educational content and enhancement with adaptivity is researched by projects like APeLS, KnowledgeTree (Brusilovsky et al., 2007), and the EU project GRAPPLE (Generic Responsive Adaptive Personalized Learning Environment) (GRAPPLE, 2011). Again, authoring of adaptive content structures is the problem: "The real bottleneck in large scale adoption of adaptive learning is still the authoring of the adaptation." (Bra et al., 2012)

To address this issue, a research group led by Alexandra Ioana Cristea started a number of research projects at the University of Warwick. Here, some of the activities by her PhD students are briefly described. Hendrix' research was motivated by a lack of appropriate authoring workflows and systems: "The authoring process, however, is time consuming and cumbersome." (Hendrix, 2010, p XIX). He tried to improve usability by implementing automatisms, improved an adaptation language called LAG and developed the graphical authoring tool Concept Adaptation Model (CAM) that displayed some difficulties regarding usability: "While technically experienced authors can succesfully create Domain Models, they struggle with creating the adaptation using the more concept Concept Relationship Types. Also authors are having issues with creating the overall course in the Concept Adaptation Model." (Hendrix, 2010, p 202) His work was continued by the PhD students Foss and Scotton. While Foss

"looked at how visualization can help users with the adaptation process" (Foss, 2012, p293), Scotton focuses on the delivery process. One of his main findings was the inferiority of code based authoring compared to graphical tools: "Evaluations have demonstrated that authors require tool support with a graphical user interface that includes a strategy library or repository to use, change and apply strategies without necessarily having to write programming code." (Scotton, 2013, p 239)

2.2. Appraisal

Effort and the difficulty of the authoring process seem to present the main obstacles in creating adaptive structures. Hence, the research reported in this paper focussed on a concept that is based on linear content and its corresponding creation process. Problems regarding unfamiliar workflow would be avoided because most lecturers are used to creating linear content. Previously created content is also taken into account: in many cases content already exists for a specific topic, even in variations created by different authors in their individual style, in particular in university networks like Atlantis University.

Reusage of existing content has been addressed by some researchers. For example, Foss stated that the material should be decomposed into different media types while it is imported (Foss, 2012). However, the recomposing process is not mentioned, although it is very important to consider the effects any changes to the content might have. Since all the content components are interrelated, each component is distinct depending on the existence or absence of other components. For example, a text would have been written differently depending on whether or not, respectively other figures are used. It is therefore necessary to specifically address whether adaptive learning content is based on linear content.

3. Adaptive eLearning based on authoring

As outlined above, established methods of adaptive eLearning content creation are not accepted by many potential authors. The creation process does not meet established authoring workflows and it does not seem to comply with many authors' ways of thinking. In the following, the challenges to the creation

of adaptive content are reflected upon, and a concept is proposed to overcome respective problems.

3.1. Storytelling aspects for adaptive eLearning

Of course, content needs to be adaptive for adaptive eLearning. For sequencing purposes, this means that the content needs to be decomposable and recomposable in different ways, for example by changing the order of sections or by hiding parts of the content. The more parts of the content should be freely reassembled, the more they need to be independent of each other. Hence, preconditions should be kept at a minimum for the content sections. All remaining dependencies have to be described explicitly – not occasionally through several layers. In the following, the characteristics of linear content are briefly analysed with respect to the demands of authoring adaptive eLearning content, drawing on aspects of research on narratives.

The soviet formalist and folklorist Vladimir Jakowlevič Propp, one of the founders of morphology, researched constant basic narrative elements (Propp, 1958). By analysing Russian fairy tales, he noticed an immutable in-depth structure. Besides defining character types, he could distinguish a limited number of functions for the narratives that always appear in the same order. While the content may differ, the functions' impacting on the course of the story are unalterable (Grasbon, 2001). Thus, sections cannot be moved without changing their function and hence modifying their purpose.

The French literary theorist Roland Gérard Barthes stated that sections of narratives are all related: “Narrative thus appears as a succession of tightly interlocking mediate and immediate elements” (Barthes, 1966) and “the meaning does not lie ‘at the end’ of the narrative, but straddles it” (Barthes, 1966). The problem for adapting purposes is that according to the computer game designer and interactive storytelling researcher Chris Crawford these interdependencies build a complex structure that is nearly impossible to realise: “Stories are complex structures that must meet many hard-to-specify requirements.” (Crawford, 2004, p 14)

Figure 2 shows a simplified example for a linear content structure. Regarding the preceding paragraphs, it illustrates that

linear content does not consist of just concatenated sections but all the sections are related. Some of the relations could be set explicitly, such as "enemy has attacked" or "student did read text." However, during an authoring process most of the relations are set for the better flow of the content because it *feels* right – and therefore are hard to describe, resulting in a linear structure with *the* order the content is presented. Any changes to the content – even small fractions like one word – would most probably require a reordering process.

Figure 2. Simplified diagram of the internal structure of linear content: Arrows indicate pre- and post-conditions of the linear content (symbolised by the row of bricks) and indicate the complex interrelationships between the content elements as mentioned by (Barthes, 1966) and (Crawford, 2004, p 14).

According to practical content creation literature, for example (Cowgill, 1997; Field, 1992), it is normal to change content and structure until everything fits together. Regarding the area of eLearning, Information Design serves to organise eLearning content (Weber, 2008) and uses the same continuous reorganisation process, because design expresses content: "In order to satisfy the information needs of the intended recipients, information design comprises analysis, planning, presentation, and understanding of a message – its content, language, and form" (Pettersson, 2002). In summary, these observations can be listed as follows:

- We can assume that in many cases automatically generated or sequenced content is only second best compared to pre-authored content.
- Changing any content section, even a word, may cause a butterfly effect. Possibly, big portions of the content have to be changed because of one word. Due to the implicit conditions this can be problematic for the adaptation system, the author, or both.
- Because adaptive sequencing means changing the order and merging content from different

contexts, it should only be done if necessary and in a clustered way to avoid breaking the interrelations of the content.

3.2. The concept: "coherence"

To provide automatic seamless adaptation from previously authored linear content, a system would need in-depth knowledge of the content, the language, the author, and more, for macro-adaptation and micro-adaptation of the content. All the content's components like text, but also figures, animations, and films would be required to be interpreted automatically. Alternatively human authors could create intermediate content for a fluent presentation. However, this would be nearly impossible because of the amount of necessary intermediate content pieces, and therefore would involve a lot of work for interdisciplinary teams of specialists. In view of the objectives pursued by the research project presented, a simpler approach was chosen.

Here, research focuses on macro adaptation by sequencing of linear learning content. This could be content specially designed for a system based on the concept of this research, but also pre-authored content, for example for already held classes, or customised content. To develop the concept, potentially existing authoring artefacts are investigated, followed by an exploration of their use for decomposing and recomposing the content.

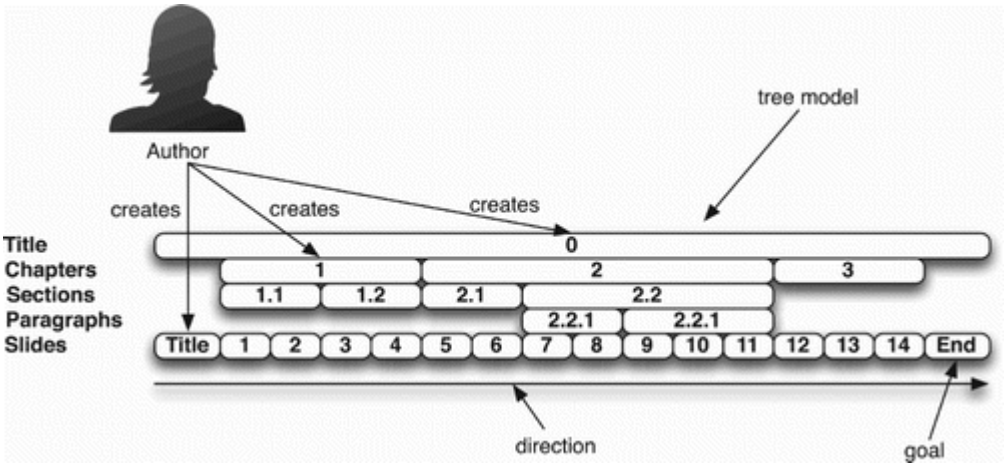
3.3. Delinearise content

As mentioned above, linear content is a sequence of sections with complex relations. This does not help to decompose the content, but more information is hidden within a linear structure:

- A goal at the end of the sequence.
- A direction through the structure: from the beginning towards the end.
- Usually a tree based structure: chapters, sections, and paragraphs.

Moreover, the author's characteristics including his/her didactic approaches and view of the domain is embedded into each piece of content and its structure, see Figure 3. This is in contrast to the multi level models that try to separate all different kinds of meta information.

Figure 3. Structure of sectioned linear content: The linear content itself consists of slides, begins with the title slide and goes linearly to the end, which normally corresponds with the goal of learning content in terms of having gone through all the content and also understood it. The horizontal arrow under the content shows its direction. Above the content the tree structure is illustrated with bricks that show the numbers of the chapters, sections, etc. The figure also shows how the author of this content has created both content and structure.



The structure information listed above is normally part of the documents' meta-information and can be imported automatically. In case of newly created content, this structure information can be set without any additional effort by using appropriate tools. Without adding additional content, the structure and its presentation is comparable to the standard flow behaviour of IMS Simple Sequencing (Norton, Ostyn, Panar, and Towle, 2003).

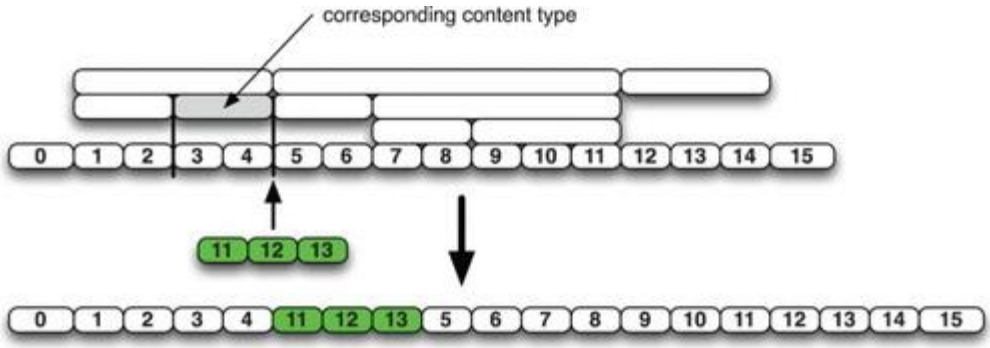
To delinearise this kind of content, additional content must be added and the structure needs to be extended. In a university network like Atlantis University, many lecturers have created their own content, explaining and presenting the same topic but differing for example regarding instructional methodology, assessments, figures, structure, wording, and ways of explanation. To be able to merge these content structures, related fractions like slides, sections, and chapters of these different linear contents can be defined. These relations are called *content types* here.

Changing to another content path does not only change the way of explanation but the entire context, comparable to change from one lecturer's class to another lecturer's class. Hence, constantly jumping around might confuse the learner more than it helps even if the additional content might be beneficial on its own, because the flow of the content sequence is disrupted. Since this lies in the nature of such adapting by merging content, it cannot be prevented entirely. However, using the original structure as far as possible would harm the characteristics of linear content as little as possible, discussed in Section 3.1 *Storytelling Aspects for Adaptive eLearning*:

- Succession of tightly interlocking mediate and immediate elements (Barthes, 1966).
- Complex structures that must meet many hard-to-specify requirements (Crawford, 2004, p 14).
- Moving a part to another position changes its purpose (Propp, 1958).

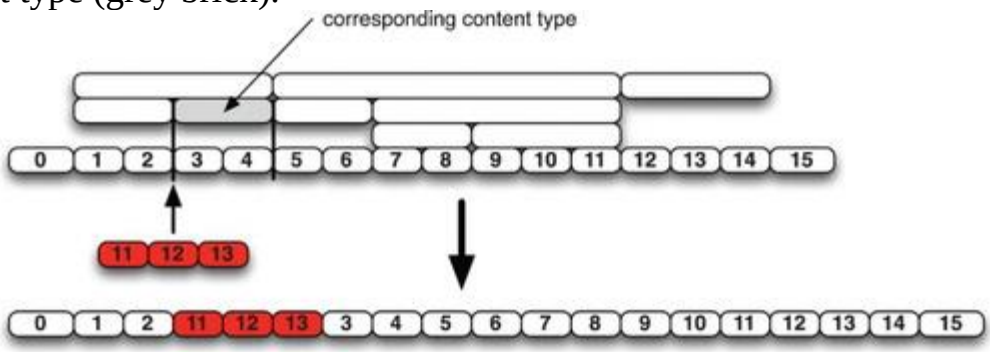
Consequently, recomposing should be done in a way that the source content's structures are changed as little as possible. The tree structure of the linear content with its chapters, sections, paragraphs, etc. describes groups of content sections. Sections within a group are more tied together than those sections that are outside this group. The margins between groups describe locations in the sequence with fewer relations compared to locations inside those groups, making them preferable candidates for branching from one linear sequence to another. To avoid jumping around in the content space, inserted content should be treated differently with respect to its relevance: alternative content should be inserted at the end of a group, compare Figure 4. Thus, depending on the user's interaction, this inserted content can be changed or dismissed without influencing the currently presented path. Conversely, content that *must* be presented should be added at the beginning of a groupto give the system a better chance to react on any implications this insertion might have (see Figure 5).

Figure 4. Insertion of alternative content sections: Another author's content (green bricks) is inserted at the end of the group of content sections belonging to the same content type (grey brick).



If another author's content is inserted, all parts of his/her content should be inserted that are required for understanding. Not all of the author's previous content needs to be presented but only content presenting aspects that are not explained in the current content path. Thus, a system needs only to take those content sections into account that are not related to previously presented sections. The related sections are grouped by *content types*, as mentioned above.

Figure 5. Insertion of content sections that must be presented: Another author's content (red bricks) is inserted at the beginning of the group of content sections belonging to the same content type (grey brick).



3.4. Sequencing strategies

Although many more strategies are possible, two basic different sequencing strategies have been identified: *Change and fall back* and *change and stay*. Many others like randomly chosen sections or showing all available content make little sense.

Change and fall back favours the path the recipient has started with. After transition, the system would try to return to the original author's sequence as soon as possible. This strategy is

valuable in case a student would like to make sure he/she was presented all the requisite content that the lecturer – in many cases also the author of the original sequence – considers to be important for the lectures and the exams. In most cases, the original linear sequence is shown that is only interrupted by short digressions, for example for alternative explanations in case of comprehension problems. The behaviour of this strategy is comparable to String of Pearls.

Change and stay transitions as little as possible by preferably moving on along the current path. After any transition, the system would try to build the rest of the path with the sequence the author has intended for the path the recipient has transitioned to. As a positive aspect, it is very likely that after a user has chosen to change the sequence and is satisfied with the new one this is a good fit. Consequently this could be taken as a feedback to adjust user preferences. The behaviour of this strategy is comparable to a concept of in-between branching and rule-based logic.

Research procedures:

1. Preparing the theoretical framework by reviewing the literature and studies related to Arabic and English related to the current research variables to benefit from them in the research stages
2. Preparing a list of adaptive multimedia production skills in light of the analysis of literature and related studies, approving it by presenting it to the arbitrators, and making the necessary adjustments to reach the final list of skills
3. Preparing a list of the criteria needed to build an interactive mobile learning environment by presenting it to the arbitrators, and making the necessary adjustments to reach the final list of criteria.
4. Preparing the e- content of the selected topics.
5. Preparing measuring instruments:
    - An achievement test for the cognitive aspect of adaptive multimedia production skills.
        - Adaptive Hypermedia Product Score Card.
        - Presenting the tools to a group of arbitrators in the field of educational technology to ensure

their suitability for application, verify the validity and stability of the tools, and make the necessary adjustments to reach the final image of the tools.

6. Designing an interactive mobile learning environment according to the two types of activities practice. Then he presented it to arbitrators in the fields of educational technology, and tested it on an exploratory sample of the research community, making the necessary modifications.
7. Choosing the research sample from the students of the fourth year, Department of Educational Technology, and dividing them into groups as shown in the experimental design.
8. Applying measurement tools individually and before on the research sample.
9. Applying the experimental treatment material represented in an interactive mobile learning environment.
10. Applying the measurement tools individually and dimensionally to the research sample.
11. Data statistical analysis, interpretation, and discussion.
12. Reaching, discussing and interpreting the research results.
13. Submitting proposals, recommendations and proposed research.

Research tools:

1. Achievement test for adaptive Hypermedia production skills:

The objective of the cognitive test is to measure the cognitive aspect of adaptive multimedia production skills. The test consisted of 30 multiple-choice statements. The validity of the test was calculated by: The validity of the arbitrators: The suitability of the test as a measurement tool was determined by presenting it to (3) of the arbitrators, to ensure the validity of the test and its relevance to the research group, and their opinions agreed that the test measures what was set to measure and that it fits the research group. The coefficients of ease, difficulty and discrimination were calculated to ensure the suitability of the test phrases to the research group, and the coefficients of ease extended from 0.75: 0.33, while the coefficient of discrimination came between (0.18-

0.22), and the Alpha Cronbach coefficient for the cognitive test came (0.85), which indicates the stability of the cognitive test.

2. The evaluation card:

The evaluation card aimed to measure the performance aspect of adaptive multimedia production skills. The evaluation card consisted of 4 main axes and 50 sub-measures.

a) **Validity of the peripheral comparison:** The card was applied to a survey group consisting of (30) learners, and the learners' scores were arranged in descending order to determine the highest quadrants to represent a group of high-level learners in the skills under study (33%) and the lowest quadrants to represent the group of low-level learners in Those skills by (33%), and the significance of the differences between the two groups was calculated.

Table (1): The significance of the differences between the highest and lowest quartiles in the expressive performance evaluation card

value	W	U	Top Quadrant		Lower quadrant		Variables
			Average grades	Total ranks	Average grades	Total ranks	
- 3.80**	55.00	0.00	15.50	155	5.50	55.00	Total card grade

(**) D at 0.01 (*) D at 0.05

It is clear that there are statistically significant differences between the groups with the highest quartiles. Which represents the learners with a high level in the skills under research and between the group with the lowest quartiles, which represents the learners with a low level in the skills under research in favor of the group with the highest quartiles, as all values are statistically significant at the level of significance (0.01), which indicates the validity of the card and its ability to distinguish between groups

b) **Secondly, Reliability:** The stability of the analysis model was calculated by calculating the correlation coefficient between the three assessors (X, Y, P) by applying it to an exploratory sample of (30) students whose performance was monitored and then calculating the correlation coefficient between the scores.

Table (2): Stability transactions for the expressive performance rating card (n = 30)

Observations	X.Y	X.P	Y.P
Link coefficient	0.82**	0.94**	0.87**

(**) D at 0.01 (*) D at 0.05

The high stability transaction values between the three evaluators are evident at the indication level (0.01), indicating that the analysis Form has a high degree of stability.

Research results:

As for the first hypothesis of the research, "There is no statistically significant difference at the level of ≤ (0.05) between the mean scores of the students of the experimental and control groups, in an interactive mobile learning environment in the cognitive aspect of adaptive multimedia production skills."

To verify the validity of the first hypothesis of the comparison between the experimental group and the control group, the T-Test was used to identify the significance of the difference between the two groups. The results of the cognitive test are presented below

Table (3): averages, standard deviations, and significance (T) of the experimental group and the control group in the post application of the cognitive test

Imp size	ETA box	Sig level	value of Sig level	Deg of freedom	value of "T"	scale deviation	Av/ arith	No.	Gr	T/ Deg
Big	0.95	sign	0.00	58	4.53	1.22	29.17	30	experimental	30
						3.28	78.87	30	control	

By extrapolating the results in Table (3), it becomes clear that the calculated value of (T) amounted to (4.53), which is a statistically significant value, where the value of the significance level (0.00), which is a statistically significant value, and then the first hypothesis is rejected and reformulated, meaning that "there is a statistically significant difference when Level ≤ (0.05) between the mean scores of the students of the experimental and control groups, in an interactive mobile learning environment, in the cognitive aspect of adaptive multimedia production skills.

As for the second hypothesis of the research, "There is no statistically significant difference at the level ≤ (0.05) between the mean scores of the students of the experimental and control groups, in an interactive mobile learning

environment in the cognitive aspect of adaptive multimedia production skills."

To verify the validity of the first hypothesis of the comparison between the experimental group and the control group, the T-Test was used to identify the significance of the difference between the two groups. The results of the cognitive test are presented below

Table (4): averages, standard deviations, and significance (T) of the experimental group and the control group in the post application of the cognitive test

Imp size	ETA box	Sig level	value of Sig level	Deg of freedom	value of "T"	scale deviation	Av/ arith	No.	Gr	T/ Deg
Big	0.99	sign	0.00	58	16.75	0.36	185.25	30	experimental	200
						1.23	125.39	30	control	

By extrapolating the results in Table (4), it becomes clear that the calculated value of (T) amounted to (16.75), which is a statistically significant value. Level ≤ (0.05) between the mean scores of the students of the experimental and control groups, in an interactive mobile learning environment in the performance aspect of adaptive multimedia production skills.

Interpretation of the results:

Interpretation of the results is poor and requires further presentation

1. The e-learning environment provided a Moodle of interaction of all kinds (teacher with learner - learner with learner - learner with content) and sharing between the two groups of both types and the use of communication tools led to increased interaction.
2. Ease of use of the e-learning environment esayclass enables learners to make optimal use of the environment and thus access content easily, master skills, implement required activities, communicate and interact with learners and exchange experiences
3. The diversity of activities and learning resources in the learning environment, including videos, images, and infographics, led to attracting learners' attention to the content and, as a consequence, to an increase in achievement.
4. The link between the educational content and the practical

side and the performance side led to the integration between the high level of achievement and skills.

5. Through social constructivist theory, the learning process is based on organizational methods that enable the learner to feel the surrounding environment. Motivation plays a key role in this interaction. In the sharing of drawings, learners are motivated to recognize the quality of their produced drawings and compete with their colleagues.

Research recommendations:

1. The necessity of applying the mobile e-learning style in educational institutions.
2. The necessity of training educational technology specialists and computer teachers on the optimal use of the interactive mobile learning environment.

Suggested research:

1. Research on social learning platforms and other variables such as: deep learning, engagement in learning.
2. The effectiveness of using mobile learning on developing higher-order thinking skills.

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