

# Designing a Gamification-Based Learning Environment and Its Impact on Computer Cognitive Aspects Among First Grade at Middle School Students

**Sami Ben Shamlan Bakhit Al-sulami**

Assistant Professor of Educational Technologies,  
Faculty of Education, Umm Al-Qura University

## Abstract

This research paper aimed to expound on designing a learning environment based on gamification and its effects on cognitive aspects of computer skills for first-grade intermediate students using a quasi-experimental research design with two groups in focus – an experimental group (n=28) and a control group (n=24). The total sample consisted of 52 students selected cluster-randomly from the first-grade middle school students studying in public intermediate schools in Jeddah. The results showed statistically significant differences at the level  $\alpha \geq 0.05$  between the mean scores of the experimental group and the control group in the posttest of the computer achievement test in favor of the experimental group. The study gave ground to using gamification in computer course design at different learning stages in Saudi Arabia.

## Keywords:

*Educational environment, gamification, computer skills.*

## Introduction

In the past few years, the world has witnessed many developments in life. Information technology has revolutionized all walks of life. Educational systems have been no exception to undergoing such unprecedented changes. In the late first decade of the third millennium, educational systems sought to invest in technological advancements to make the best possible use by conducting studies and integrating technology into the field of education, which has contributed tremendously to serving the community and achieving the goals of educational systems.

E-learning does not exclude teachers' roles but rather adds new dimensions to education. Instead of being only a transmitter of knowledge, the teacher's role has shifted to become an organizer and facilitator of the learning-teaching processes. Such new roles require teachers to possess educational and technical skills to keep pace with the present-day realities [1, p. 89].

In view of the various advantages of e-learning in education, whether for the teacher, the learner, the school

or the community, and as a result of the rapid developments the world is witnessing in terms of modern technologies, which include various aspects of life, the field of education comes in the forefront to take advantage of the positive aspects of contemporary technology that work in the best interest of developing learners' technical skills and enhancing their motivation for learning better and faster, which is the result and desired goal for any educational system.

In fact, several studies have shown deep interest in the role played by modern technologies in the educational process [2, 3, 4, 5]. They recommended integrating modern technologies into education in view of the various advantages they entail for the teacher, the learner, and the educational institution.

Based on the foregoing, gamification is highly significant if applied in the educational field. It adds an atmosphere of fun, suspense and motivation to the learner. Besides, it is one of the novel topics not yet significantly addressed by Arab scholars despite its importance in education. Since this study aimed to develop the cognitive aspect of computer skills among first-grade middle school students in Jeddah, gamification has focused on achieving the study purpose.

## Research problem

In line with the 2030 ambitious vision, the Kingdom, represented by the Ministry of Education, seeks to develop curricula through diverse initiatives to integrate modern technologies and employ them in the educational process. Looking at the reality of computer and information technology education in our educational institutions, there is a marked failure to keep pace with the use of teaching methods and modern technologies may lead to a weakness in the computer skills of the learners [6, 7, 8].

Several conferences also recommended the need to focus on developing these skills through modern technologies. Of these conferences, the Third International Conference on E-Learning and Distance Education - Practice and Desired Performance – held in Riyadh (2013), and the Fourth International Conference on E-Learning and Distance Education - Innovative Learning for a

Promising Future - Riyadh (2015) recommended the necessity of activating modern technologies in designing electronic learning environments and integrating them in education. The problem of the study can be identified in the weak cognitive aspect of computer skills among first-grade middle school students. It is in this context that the present is conducted.

**Questions of study**

The present study attempts to find answers to the following main question:

- What is the effectiveness of an educational environment based on gamification in developing the cognitive aspect of computer skills among first-grade middle school students?

This questions has two sub-questions:

- What are the appropriate computer skills among first-grade middle school students in Jeddah from the point of view of experts and specialists?
- What is the effectiveness of an educational environment based on gamification in developing the cognitive aspect of computer skills among first-grade middle school students in Jeddah?

**Definition of terms**

**Educational environment**

It is procedurally defined as an integrated system of interactive educational activities, including objectives, topics, multimedia, educational activities, procedures, and evaluation methods. It is designed according to the elements of digital gamification to develop computer skills and achievement motivation among first-grade middle school students.

**Gamification**

The procedural definition of gamification is the use of game elements such as points, level progress, and leaderboards by the teacher and the learner to accomplish educational activities for the units “My Computer Friend” and “Write My Achievements” through an electronic learning environment to develop computer skills and achievement motivation among students middle school first grade.

**Computer skills**

This is taken to mean the set of educational, mental and performance activities that the learner should know and practice after the learning process has occurred in the fourth and fifth units of the computer and information technology course for the first, middle school grade and in which he should follow the easy and accurate method.

**Procedures of study**

**First: Methodology**

The study follows the experimental method with its quasi-experimental design, known as the design of the two groups: the control and the experimental with pre and post measurements (Quasi-Experimental Methods). As this study seeks to identify the impact of the independent variable (gamification-based learning environment) on the dependent variable (computer skills) for first graders' average in the Kingdom, the experimental method is used to answer its questions. The following table can illustrate the quasi-experimental design of the study:

**Table 1** Quasi-experimental Design of Study

Study Groups	Pre Measurement	Experimental trial	Post measurement
Control group	Computer skills achievement test	Traditional teaching method	Computers skills achievement test
Empirical group		Digital gamification teaching method	

**Second: Study variables**

The variables of the study come in two forms:

**1. Independent variable:** Experimental trail for gamification environment

**2. Dependent variable:** Cognitive aspect of computer skills

**Third: Study population**

The population of the study comprised 18728 students, all in the first-grade middle school stage, who study in public education schools in Jeddah during the second semester of the academic year 1439-1440 AH. The Education Department includes six education offices: the Office of The North, the East Office, the Central Office, the Safa Office, the Naseem Office, and the South Office.

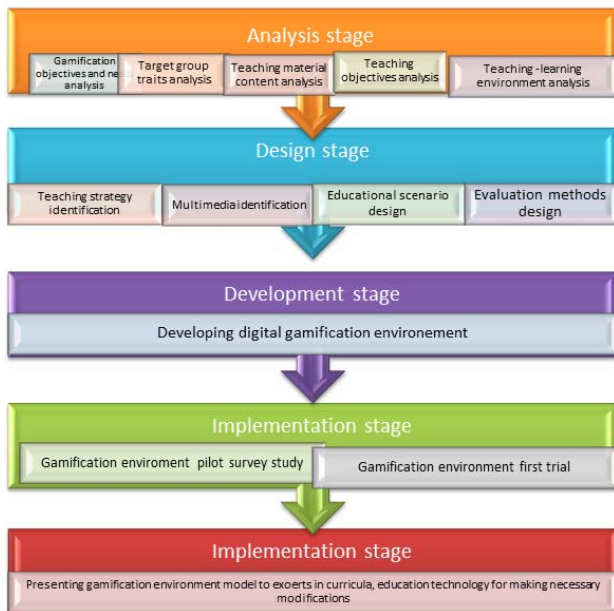
**Fourth: Study tools and instrument**

1. Gamification (designed by the author of the study)  
 Many instructional design models have been dealt with in the literature. [8, pp. 166-186] points out some of such models (Kemp, 1985, Dick & Carrey, 1985, Clark & Star.1981, and Gerlach & Ely, 1980). Examining such models and other models, it is observed that they share the overall steps of educational design included in the general model of the educational design known as (ADDIE) is the general model is the basis of all previous designs ones. These models revolve around five main stages, all projected in the so-called general model of instructional design. This is a procedural model involving the following five stages: analysis, design, development, implementation, and evaluation. These stages are organized so that a stage does not start until after completing the previous one.

**Table 2.** Study Tools & Materials

	Materials		Tools
1	Gamifications environment	1	Achievement Computer Achievement test
2	Teacher's guide to gamification		
3	Student's Guide to gamification		

Touched on above, this study has adopted the general model of instructional design (ADDIE Model) to design and build a digital gamification environment for teaching the two units (My Computer Friend), (Write my achievements) on the grounds of their comprehensiveness and flexibility. Some adjustments were made to these stages in proportion to the nature of the content and the nature and traits of the students, the clarity of its stages, and its relevance, as illustrated in the following figure:

**Figure 1.** Digital Gamification Design in Conformity to ADDIE Instructional Design Model**First Stage: Analysis**

The analysis stage is the cornerstone for all digital gamification environment design subsequent stages. It involves the following steps:

**1-** Needs analysis and general goal definition of designing the digital gamification environment:

While conducting pilot study, it was noticed that there is weakness in some computer skills among middle school students. In addition, teachers' use of computer and e-learning methods in general was poor. There was a marked weakness among teachers in using educational games and

their various elements such as feedback, leaderboards, medals, and points in teaching computer content to their students. These observations prompted the researcher to conduct the study on gamification to convert the content of the two units (computer friend, write my achievements) into electronic content.

**2-** Analysis of target group characteristics:

The gamification-based learning environment design was administered to the study participants - first-grade male students in Jeddah governorate. All participants were aged between (12-14) years. Their language is Arabic; they come from the same cultural background; they all belong to middle-class socio-economic level. As for the first-grade middle school participants' academic and mental achievement level, they are students possessing the needed abilities to learn, acquire information and exhibit the performance skills through practice, interaction with their teachers and their colleagues alike.

**3-** Analysis of the educational material content:

The content of the computer book, designed for first-grade middle school students and usually taught in the second semester of the academic year 1439-1440 AH, was analyzed. It included (3) academic units. The two units (Computer is my Friend & I Write my Achievements) were purposefully selected because they contain many information and skills related to dealing with computers. The two units also included 12 sub-topics as listed hereunder:

1. Data types and input, storage and output techniques.
2. Touch typing and keyboard recognition.
3. Inserting images and audios into computer.
4. Touch typing training.
5. Text and document processing and its advantages.
6. Dealing with word processor.
7. Text editing.
8. Text formatting.
9. Paragraph formatting.
10. Creating tables.
11. Working with pictures.
12. Page formatting and printing.

**4-** Analysis of educational teaching-learning objectives:

The general objectives and behavioral objectives (cognitive, skill, and affective / emotional) were defined for the two units. The results of the analysis of the general and behavioral objectives for both units and subjects were explained.

**5-** Analysis of the educational environment:

For the study purpose, it was ensured that all physical material or human resources are available for the success of the educational process including computers availability in schools in which the field study will be conducted.

### Second Stage: Design

This involves the development of the initial scenario used in building a digital gamification environment to teach the two units (My Computer Friend, I Write My Achievements) in light of their content, educational goals, students' characteristics and the educational environment that were previously identified in the analysis stage. This stage included the following steps:

- 1- Identifying the teaching strategy
- 2- Identifying the multimedia for a gamification environment
- 3- Designing an educational scenario for a gamification environment
- 4- Designing evaluation methods and tools. The evaluation methods and tools were identified as follows:
  - Pre-evaluation
  - Constitutive evaluation
  - Final evaluation

### Third Stage: Development

At this stage, the educational scenario for the digital gamification environment was written and produced. This stage involved the following dimensions:

#### - Producing gamification environment:

The scenario was designed using the two units (Computer is my Friend & I Write my Achievements). The topics of the two units were divided into sub-tasks, each of which is associated with several activities. Each student should complete each task in addition to its activities to be able to pass the topic and be promoted to the next one. There were 15 teaching-learning educational tasks in the two units, with 15 educational activities in them as well. There were 39 screens for the digital gamification environment, including access screens, the main screen defining the environment's objectives and components, a feedback screen after each task and pre-tests and post-tests.

### Fourth Stage: Implementation

The gamification-based learning environment was implemented with the aim of preliminary experimentation to identify the ease with which the content embedded within the environment will be displayed, the clarity of all its elements and components such as texts, images, audio, and video clips, as well as the clarity of instructions related to how students use the environment.

### Fifth Stage: Evaluation

The gamification-based learning environment was presented to a group of arbitrators and specialists in the field of educational technology, specialists in curricula and teaching methods, as well as computer teachers to enhance its validity and suitability for the purpose for which it was designed and its adherence to technical and educational standards for the production of digital electronic environments and media.

### List of computer skills for first grade middle school students (Prepared by researcher)

To identify the computer skills, the following steps were taken:

1. Identification of the sources of building a list of computer skills.

The list of skills was built in the light of many sources, including the following:

A. The academic content of the fourth unit (Computer is my Friend) and the fifth unit (I Write my Achievements).

B. Educational literature in the field of computer and information technology.

C. Course intended learning objectives for the computer course at the middle school stage in the Kingdom.

2. Initial structure of the list of computer skills.

The tentative list of computer skills was prepared based on the previous sources.

The initial form included thirteen primary skills, each of which was classified into sub-indicators. The skill of importing audio to a computer included (12) sub-indicators, while the skill of listening to audio files from the computer contained (3) sub-indicators. Moreover, the skill of importing images and pictures to a computer had (11) sub-indicators. As for the skill of printing scanned images, there were two sub-indicators. Concerning touch typing skills, it included (10) sub-indicators. The skill of dealing with word processors included (13) sub-indicators, while the skill of text editing had (10) sub-indicators. Besides, text formatting and paragraph formatting skills included (4) sub-indicators each. The skills of creating tables and dealing with images included (9) sub-indicators each. As for page formatting skills, there were (6) sub-indicators. Finally, the skill of page printing had (4) sub-indicators. Thus, the initial form of the list of skills consisted of (97) sub-indicators.

3. Computer skills list adjustment

The list of skills was administered to a group of experts in the field of curricula, teaching methods and educational technology to better ensure its validity for first-grade middle school students and the extent of its language accuracy, and whether there should be some addition, deletion, modification, formulation some skills to the list or not.

4. Computer skills list final form

Having applied all the necessary modifications recommended by expert referees, the list of skills in its final form consisted of (13) main skills, which included (97) sub-indicators, which aptly answer the first question of the study.

### Tools of the Study

Preparing computer skills achievement test for first-grade middle school students. For the study main purpose, it was necessary to prepare an achievement test addressing the cognitive aspect of computer skills. The test preparation was done based on the following steps:

#### 1. Identification of the purpose of the test

The test was designed with the aim of measuring the cognitive aspect of computer skills for first-grade intermediate students in Jeddah.

#### 2. Identifying test pattern

Multiple-choice questions were used in the test, being the best option in measuring the extent to which cognitive goals have been achieved. They are flexible, can be formulated in multiple ways, and are easy for grading.

#### 3. Formulation of test questions

When formulating the test questions, the conditions for good test preparation were taken into account. 36 Multiple-choice questions were formulated according to the following criteria:

- Random distribution of answers.
- Four alternatives, which reduces the guesswork effect of students.
- Avoidance of including an answer to a previous or next question in one of the questions.

**Table 4.** Computer Skills Performance Test Characteristics

No.	Units	Topics	No. of Objectives	No. of Classes	Behavioral Objectives Levels						Total
					Recollection		Comprehension		Implementation		
					Number	No. in Test	Number	No. in Test	Number	No. in Test	
1	Computer is my Friend	Data Types & Input, Storage, Output Techniques	12	1	1	1	1	13	1	19	3
		Touch Typing & Keyboard Understanding	14	1	1	30	2	18.5	-	-	3
		Downloading Pictures & audiofiles to Computer	9	1	1	14	-	-	2	20.2	3
		Touch Typing Training	4	1	1	11	-	-	2	35.31	3
2	I Write my Achievements	Text and Document Processing	16	1	2	3.27	1	17	-	-	3
		Dealing with Word Processor	7	1	1	22	-	-	2	15.21	3
		Text Editing	10	1	1	6	-	-	2	36.10	3
		Text Formatting	6	1	1	28	-	-	2	4.25	3
		Paragraph Formatting	4	1	1	16	-	-	2	29.7	3
		Creating Tables	6	1	1	9	-	-	2	23.26	3
		Dealing with Pictures	7	1	1	32	-	-	2	12.33	3
		Page Formatting and Printing	6	1	1	34	-	-	2	8.24	3

4. Content validity

Logical validity was followed to identify the test validity. It means the extent to which the test represents the objective it measures. During the preparation of the test paragraphs, it was taken into account that they should represent the objects being measured. This type of validity was calculated by building a specification table for the test, as illustrated in the following table:

5. Face validity of the test

After preparing the test in its initial form, it was presented to a group of arbitrators specialized in curricula, teaching methods and educational technology, and a number of computer and information technology teachers.

6. Pilot survey study of computer skills achievement test

The test was administered to (20) students from the same study population, all in the first grade middle school students at Jabal Al-Noor Intermediate School in Jeddah

**Table 5.** T-values indicating the differences between the mean scores of the students of the experimental and control groups in the post-application of the cognitive achievement test for computer skills

levels	total	No.	Mean	St.D	F	t	(Sig)	η <sup>2</sup>		d
								Size effect		
Remember	Experimental	28	9.57	3.07	50	9.13	0.000	0.625	2,54	
	Control	24	3.29	1.49				large	large	
comprehension	Experimental	28	3	1.12	50	6.21	0.000	0.435	1,73	
	Control	24	1.29	0.81				large	large	
Applications	Experimental	28	13.61	5.45	50	7.42	0.000	0.524	2,06	
	Control	24	5	1.72				large	large	
Total	Experimental	28	26.18	9.28	50	8.41	0.000	0.586	2,34	
	Control	24	9.58	2.86				large	large	

Results

**Research Questions #1** What are the appropriate computer skills among first-grade middle school students in Jeddah from the point of view of experts and specialists?

To answer this question, a list was prepared that includes the main computer skills and their sub-indicators. In its initial form, the list included thirteen main skills, each of which included several sub-indicators; Where the number of sub-indicators reached (97) sub-indicators, and then they were presented to a group of experts and specialists to judge their suitability for the characteristics of first-grade intermediate students in Jeddah, the soundness of the linguistic formulation of those skills, and the extent to which they are related to the objectives of the study, and after making the appropriate adjustments that he referred to The judges reached the final picture of the list, which consisted of thirteen main skills, and (97) sub-indicators.

- **Research Questions #2** What is the effectiveness of an educational environment based on gamification in developing the cognitive aspect of computer skills among first-grade middle school students in Jeddah?

To verify the effectiveness of the digital gamification environment in developing the cognitive aspect of computer skills for first-grade students in the middle school in Jeddah, the test was applied remotely to the two groups of the control and experimental study. The arithmetic averages and standard deviations were

calculated. The T-test values indicate the differences between the mean scores of the students of the two control groups. The effect size was calculated using the strength of the relationship between the two variables (the size of the

explained variance). The value of the square of Eta (η<sup>2</sup>) was calculated from it. The standard difference index between two averages was calculated, from which the Cohen index (d) was calculated, and table (5) shows the results for that.

As Table 5 indicates, there are statistically significant differences (at the level of α ≥ 0.05) between the mean scores of the experimental and control groups in the posttest of the computer achievement test as a whole in favor of the group with the highest mean value (the experimental group). The t-value is 8.41, which is a statistically significant. The calculated statistical significance value (0.000) which is less than the significance level value (0.05).

Likewise, there are statistically significant differences (at the level of α ≥ 0.05) between the mean scores of the experimental and control groups in the posttest of the achievement motivation scale as a whole in favor of the group with the highest mean value (the experimental group) in the three test levels. The t-values ranged between 6.21-9.13, which is a statistically significant. The calculated statistical significance value is 0.000, and this value is less than the significance level value (0.05).

Insofar effect size is concerned, the effect size of the gamification-based learning environment on the cognitive



aspect of computer skills as a whole was large. The value of eta-squared ( $\eta^2$ ) for the test as a whole was 0.586, which means that 58.6% of the total variance of the dependent variable (the cognitive aspect of computer skills) stem from influence of the independent variable (the educational environment based on digital gamification). This result is confirmed by the Cohen index (d) value, (2.34), which is much greater than the minimum significant effect according to Cohen's indicators to explain the size of the effect, which is (0.8).

The effect of the gamification-based educational environment on computer cognitive achievement tests (the level of remembering, the level of understanding, the level of application) was large. The eta square ( $\eta^2$ ) values ranged between (0.435 - 0.625), and this indicates that 43.5-62.5% of the total variance for each level of the achievement test resulted from the effect of the independent variable (the educational environment based on digital gamification). The Cohen index (d) value, which ranged between 1.73 and 2.54, confirms these results. It is much greater than the minimum significant effect to explain the effect size (0.8). Cohen's indicators can be clarified to explain each effect size using the strength of the relationship ( $\eta^2$ ) and the standard difference between two averages (d) in Table 6 below.

These results indicate the effectiveness of the gamification-based learning environment on the cognitive aspect of computer skills of the first-grade students in the middle school in Jeddah, Saudi Arabia. This answers the research question, What is the effectiveness of a gamification-based learning environment on the cognitive aspect of computer skills of first-grade intermediate students in Jeddah?

**Table 6.** Effect Size levels Based on the Strength of relationship between the Two Variables and Standard Difference between the Means

strength of the relationship	Interpretation		standard difference between mean	Interpretation	
	value	Effect size		Value	Effect size
Eta Square ( $\eta^2$ )	0.01	Small	Cohen's Index (d)	0.2	Small
	0.06	Moderate		0.5	Moderate
	0.14	Large		0.8	Large

**Recommendations & Suggestions**

In this light, it is highly recommended to take advantage of gamification in designing computer courses in the various stages of education in the Kingdom of Saudi Arabia. Based on the results, the researcher suggests the following topics for further investigation:

1. Attitudes of computer and information technology teachers towards gamification in the Saudi environment.
2. Effectiveness of an educational environment based on gamification in modifying alternative perceptions of computer and information technology concepts among middle school students.
3. Requirements for gamification in education within the Saudi environment.

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**Sami Shamlan Al-Sulami** holds an MA and Ph.D. in educational technologies, obtained from Umm Al-Qura University in 2013 and 2020. He is currently working as a lecturer at Umm Al-Qura University in the field of educational technologies. He has taught several courses in educational technology. He has also mentored a group of postgraduate students. His research areas include educational technologies and e-learning.