

Effectiveness of a Gamification Based Training Program for Science Teachers on their Design Thinking Enhancement and their Students' Attitudes towards Studying Science

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Abstract: The study aimed to investigate the effectiveness of a Program based on Gamification on developing of Teachers' Design Thinking Skills, and their student's attitudes towards science, used the experimental approach (the Quasi-experimental Design). The study was conducted on 35 science teachers from east area of each Gaza and Khan Younis. Data were collected using the design thinking measure, and Attitudes towards Studying Science measure. Results showed statistically significant differences at significance level ($\alpha = 0.05$) between the average scores of the teachers Design Thinking Skills of the experimental group in the pre- and post- application of Design Thinking Skills measure in favor of posttest, and statistically significant differences at significance level ($\alpha = 0.05$) between the average scores of the students' Attitudes towards Studying Science of the experimental group in the pre- and post- application of Attitudes towards Studying Science measure in favor of posttest. The results revealed also that the program based on gamification has a significant impact with ($r = 0.877$) and ($\eta^2 = 0.7$) Respectively.

Keywords: (Gamification, Design-Thinking, Science learning, Attitude)

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I. Introduction

As technology accelerates and encircles students in all areas of life and entertainment, in particular, the gap between the classic classroom or learning environment and sophisticated gameplay techniques is enormous, which confusing teachers and make them facing an enormous challenge as students distract and minimize their involvement in positive and effective learning processes.

Because of the low attraction of what they find in different technologies, they can be involved if they build Attitudes towards Studying Science, Nobody can ignore the importance of the Attitudes towards Studying Science in science teaching, which makes the student automatically interact with science and engage in learning.

The main threat is to attract students to the world of entertainment and decrease their interaction in classroom environments, so many researchers have highlighted different ways to develop the Attitudes towards Studying Science. Many studies indicate that the Attitudes towards Studying Science can be developed, for instance (Adesoji, 2008) concluded that students in the experimental group developed more positive attitude towards Chemistry after the applying problem solving strategy. A similar result was found in (Zain, Rohandi, & Jusoh, 2010) which showed that instructional congruence in science education promotes positive students' attitudes toward science, especially in the constructs of the practical work of science, science outside of school, future participation in science, and a combined interest in science, to strengthen these results (Ifamuyiwa & Akinsola, 2008) concluded that the usage of self and cooperative-instructional strategies had significant main effect on students' attitude towards Mathematics. The participants exposed to self-instructional strategy had the highest post-test mean attitude score as well as the study (Fatoke & Olaoluwa, 2014) which revealed that problem-solving instructional strategy influences students' attitude towards chemistry learning, which means that the possibility of developing Attitudes towards Studying Science can be made in different ways. Even if it is important to enhance attitudes and positive ones specially, it is also important to enable teachers to design teaching in an effective and attractive way, as design teaching depends on an effective high level design thinking, searching the newest ways to do lead to gamification which success in enhancing marketing fields, and work environments.

Gamification is being used in the business industry as a way to engage employees into achieving organizational goals, as well as incentivize customers to use their products. More recently, gamification has become a powerful instructional method in K-12 education, as well as top colleges and universities.

With the fact that gamification stimulate integration and interaction to the extent of dumping and flow sometimes according to(Jiang, 2016) that found that the use of gamification in education usually promotes behavioral, cognitive, and emotional engagement, but the effect may wear off over time. There are mixed findings regarding the impact of gamification in learning outcomes which make sense with(Andriamiarisoa, 2018)which indicated that there were significant differences over time in cooperative learning, cognitive level, and personal skills when using gamified learning methods.(Papp, 2017) found that Gamification has inspired increased motivation and engagement of players. Harnessing the elements that drive relentless efforts to succeed in the virtual world can alter the effects of students and their learning experiences.In(Kocakoyun&Ozdamli, 2018) (It is seen that gamification applications are frequently preferred in virtual environment, simulation and augmented reality learning environments after mobile environments and in parallel with these, they are also preferred in learning areas such as public service, food and health.

These results encourages the researchers to look for other effects of using Gamification in Education on each of teacher thinking and students attitudes, the problem of this study came to examine the impact of employing play techniques and its elements in the design of teaching environments on students' attitudes towards science on the one hand and the effectiveness of training based on gamification in the development of Design Thinking Skills of science teachers on the other hand and the problem of the study was formulated as following in study problem description.

II. Study Problem

The study aims to investigate the effectiveness of a Program based on Gamification on developing of Teachers' Design Thinking Skills, their students' attitudes towards science, the problem was formulated in the following main question:

What is the effectiveness of a gamification based training program for science teachers on their design thinking enhancement, and their students' attitudes towards studying science?

It has the following sub-questions:

1. What are the training needs of science teachers in Palestine in the field of gamification?
2. What is the gamification based training program that meets science teachers needs in Palestine?
3. What is the effectiveness of the gamification based training program for science teachers on their design thinking enhancement in Palestine?
4. What is the impact of the gamification based training program for science teachers on their students' attitudes towards studying science?

III. Research Objectives

The study aims to achieve a number of objectives including:

1. Identify the training needs of science teachers in Palestine in the field of gamification.
2. Constructing a gamification based training program for science teachers in Palestine.
3. To identify the effectiveness of the gamification based training program for science teachers on their design thinking enhancement in Palestine.
4. Measure the impact of the gamification based training program for science teachers on their students' attitudes towards studying science.

IV. Study Hypotheses

1. There were no statistically significant differences at the level of ($\alpha \leq 0.05$) among the experimental group's science teachers in the mean scores of the design thinking on the Pre-post applications.
2. There were no statistically significant differences at the level of ($\alpha \leq 0.05$) between the mean scores on the Pre-post applications in the attitude towards studying science among the students of the experimental group's teachers.

V. Study Importance

The importance of the study is that:

- Provides a general framework for the teaching of science in the basic stage according to the gamification techniques, which benefits the teachers of science, curriculum designers and developers.

- The study defines Design Thinking Skills in general, and scientific design thinking in particular, which benefit science teachers and researchers in the field.
- The study provides a list of Design Thinking Skills and attitudes towards science and their indicators to be improved, which may benefit other researchers.

VI. The limits of the study

The study was conducted in the second semester of the academic year 2018/2019 in east area of each Gaza and Khan Younis on science teachers and their students.

VII. Study Terms:

The researchers define the study terms operationally as:

- **Gamification:**

Gamification is identified as the usage of game elements and game thinking in non-game environments to increase target behavior and engagement.

- **Design Thinking Skills:**

Design thinking refers to the cognitive, strategic and practical processes by which design concepts are developed by designers and/or design teams. In this study it refers to Understand the service users, Identify the problem, generate ideas, Prepare the prototype and Test the model.

- **Attitudes towards studying science:**

Attitudes towards studying a science course are the feelings that a student has about studying science, based on his beliefs about it (Kind, Jones, & Barmby, 2007). Attitudes toward studying science course are a conglomerate of many components including Enjoyment of Science, Self-Concept in science, value of science in society and Technology, and Future Intentions in Science, Attitudes are developed over the course of a person's life and tend to change with cognitive states.

VII. Methodology:

The study used both of the descriptive approach in determining the training needs, the Quasi-experimental Design (Pre-Post group design) to apply the program, and the constructive approach to design the program.

8.1 Data Collection Instruments:

Training needs Identification, Design thinking skill measure, Motivation measure and attitude measure were used as Data collection tools used to collect data and measure the differences in teachers' Design Thinking Skills' score and their students Attitudes and Motivation towards science learning before and after the experiment.

8.2 Scientific Practices Observation Card:

According to the results of applying Training needs Identification, the Pre-post group of science teachers was chosen, the Design thinking skill measure was applied as a pre-application. At the same time Attitudes measure were applied on their students as a pre-application then the program based on Gamification was trained. Then the measures were applied as a post-application to compare between results in pre and post application of Design thinking skill measure, and Attitudes towards Studying Science.

8.3 Data Analysis:

Data collected in the study were analyzed by using SPSS Statistics version 22 program: Normality of data was tested, according to the result Wilcoxon test conducted to determine if the difference between the pre-test and post-test of Design Thinking Skills was significant, paired samples test was conducted to determine if the difference between the pre-test and post-test of attitude was significant the value of η^2 was computed to determine the effect size of the program based on Gamification in development of Design Thinking Skills, and Attitudes towards Studying Science respectively.

VIII. Findings

Answer of first question : 1. What are the training needs of science teachers in Palestine in the field of gamification?

To find out the prevalence of the concepts of gamification in education among teachers, researchers used the observation, results showed that there was confusion in the concepts and application between gamification and Play-Based Learning. Accordingly, to identify the Science Teachers' needs the researchers prepared a needs assessment form and asked their supervisors to fill it out. Nine supervisors filled out the form and the results showed that there is a real training needs in the gamification field arranged according to priority:

1. Gamification applications and Designing gamified activities.
2. How to teach using gamified activities.
3. Using gamification in Evaluation.

Results of question 2: What is the training program based on gamification for science teachers in Palestine?

Scanning the Educational Literature, depending on both of teachers needs and Gamification concepts and principles the training program was built and judged from the Science supervisors with determine of time required.

Results of question 3: What is the effectiveness of the training program based on gamification in the development of Design Thinking among science teachers in Palestine? Answering this question started at the hypothesis that: There were no statistically significant differences at the level of ($\alpha \leq 0.05$) between the mean scores of the Design Thinking of the teachers in the Pre-post applications of Design Thinking Skills measure. First, the normality test was done, result showed at table1.

Table1: (Normality test of teachers group)

df	sig
29	0.000

As indicated in table1 the result of normality test of science teachers group showed that the group is not normally distributed as sig < 0.05, according to this result the differences were tested using Wilcoxon test: Related Samples Test as shown in table2.

Table2: (Wilcoxon test: Related Samples Test)

	df	z-test	sig
Design Thinking	29	4.724	0.000

As results shown, the Wilcoxon test value $z = 4.724$ and $sig < 0.05$, which indicates a significant difference between the post and pre application of design thinking measure. In favor of the post-application, to determine the effect size researchers applied the formula: $r = \frac{z}{\sqrt{N}}$ (TOMCZAK & TOMCZAK, 2014)

Table 3: (Effect Size r)

Design Thinking	z-test value	N	\sqrt{N}	r
	4.724	29	5.385165	0.877225

As shown above on the table (3)

Results of question 4 : What is effectiveness of the training program based on gamification on the attitudes of students towards science learning? The researchers formulate the hypothesis: There were no statistically significant differences at the level of ($\alpha \leq 0.05$) between the mean scores of the students' attitudes towards learning science in the Pre-post applications of attitude measure.

Table4: (Paired Samples T Test)

Attitude towards Science	df	Means	Standard Deviation	t-test	sig
Enjoinment of Science	64	2.600	1.539	13.620	.000
Self-Concept in science	64	4.015	3.931	8.235	.000
value of science in society and Technology	64	.862	6.398	1.086	.282
Future participation in science	64	4.123	2.546	13.054	.000

As indicated in table 4 there was a significant difference at level ($\alpha = 0.05$) between students' pre-test results and post-test result in three dimension of attitude measure:Enjoinment of Science, self-concept in science and Future participation in science, where it wasn't significant at the third dimension: value Science interactions with technology and society, These results reflect the impact of the program on positive and significant change of the near-term trends, while long-term trends such as those included in the third dimension of the scale need intensive attempts and longer time to change, , to determine the effect size the value of η^2 was computed as shown in table 5 the values of η^2 for all the scientific practices were all more than 0.14 which means that Gamifying science lessons has a big effect size in improving the Attitudes towards science among students.

Table 3 : (Effect Size η^2)

Attitude towards Science	t-test value	t ²	df	η^2
Enjoinment of Science	13.620	185.5044	64	0.743491
Self-Concept in science	8.235	67.7329	64	0.514168
value of science in society and Technology	1.086	1.179396	64	0.018095
Future participation in science	13.054	170.406916	64	0.726971

IX. Discussion

This study was conducted to investigate the effectiveness of a Program based on Gamification on developing of Teachers' Design Thinking Skills, and their student's attitudes towards science. Study results showed that there is a positive impact in raising the level of design thinking skills of science teachers of the Pre-post group after the application of Gamification program, also there was a significant difference in their students' attitude toward science in favor of the post application.

The reason of this improvement in the readings of the study variables may refers to; The philosophy of Gamification which gave students the freedom they need also gamification is designed on the attraction and interaction basics which raise up the engagement of students in the learning process on the one hand and the exciting, surprising elements of gamification were also a mean reason, the urgent need for innovation in the field of education and science education in particular, which led to the improvement of the each the teaching design as a result of enhancing design thinking and the students' attitudes of scientific students in the implementation of various educational activities,- Break down teaching stereotypes through interactive activities and enrich content by research, interaction and design skills Raise student contributions and improve their performance, Gamification Combination between thinking and implementation skills. The students are encouraged to find an active role to participate according to their preparation and abilities.

Result also showed that Gamification program make a difference in students attitude in total, but this difference was not significant in the third dimension of the measure named (Science interactions with technology and society) because the students' consciousness of science importance in life and society not completed yet, they can not connect between the phenomena and their scientific explanations which may refers to their young age and limited experience. Another reason could lead to the students' lower performance on valuing Science interactions with technology and society that their teachers don't focus on social issues especially that they rarely used the project-based learning because they haven't enough time to do.

The results of this study are consistent with other studies that examined the impact of Gamification in education, as (Jiang, 2016) study that found that the use of gamification in education usually promotes behavioral, cognitive, and emotional engagement, (Andriamiarisoa, 2018) that indicated that there were significant differences over time in cooperative learning, cognitive level, and personal skills when using gamified learning methods. (Papp, 2016) found that Gamification has inspired increased motivation and engagement of players which consistent with the result of this study.

X. Recommendation:

1. Using the basics of Gamification in education in designing the main subjects in (science, technology, mathematics) in different educational stages.
2. Training teachers to use Gamification in education in different scenarios.
3. Gamifying lessons, classes and learning environments to activate the learning process.
4. Studying the gamification basics and elements in depth and test its impact on other variables.

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