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The Effectiveness of Using an Innovative Application Based on a Gamification Approach on the Level of Engagement of Eighth Grade Students in the Sultanate of Oman

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Abstract

The study aims to determine the impact of teaching using a mobile application based on the gamification approach on student engagement in learning, among eighth-grade students in The Sultanate of Oman. To achieve the study's aim, the study adopted a quasi-experimental method based on the design of the control and experimental groups and the pre and post-application. The sample of the study consisted of 124 students in the eighth grade, divided into 62 in the experimental group and 62 in the control group. A mobile application named (Dr. Science2) was also designed based on the gamification approach for the experimental group. A learning engagement scale was also used, which had a reliability coefficient of (0.88). The quantitative data showed statistically significant differences in the post-application between the control and experimental groups attributed to the teaching method in favour of the experimental group. The study also found no statistically significant effect of the interaction between the teaching method and the social type variable in the post-application of the learning engagement scale. The study recommends encouraging and directing science curricula teachers; supervisors; and specialists toward applying the gamification approach in science lessons to achieve higher levels of student engagement in learning in general.

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فاعلية استخدام تطبيق مبتكر قائم على أسلوب اللعب على مستوى المشاركة لدى طلبة الصف الثامن الأساسي بسلطنة عمان

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وزارة التعليم

الخلاصة

هدفت الدراسة إلى معرفة أثر التدريس باستخدام تطبيق هاتفي قائم على منحى التلعيب في الاندماج في التعلم، لدى طلبة الصف الثامن الأساسي بسلطنة عمان، ولتحقيق أهداف الدراسة اعتمدت الدراسة على المنهج شبه التجريبي المعتمد على التصميم ذي المجموعتين الضابطة والتجريبية والتطبيق القبلي والبعدي، إذ تكونت عينة الدراسة من ١٢٤ طالبًا وطالبة في الصف الثامن الأساسي انقسموا إلى ٦٢ في المجموعة التجريبية و ٦٢ في المجموعة الضابطة. كما تم تصميم تطبيق هاتفي يحمل اسم (Dr. Science2) قائمًا على منحى التلعيب للمجموعة التجريبية، كذلك استخدم مقياس الاندماج نحو التعلم والذي بلغت قيمة معامل الثبات (٠.٨٨). وأظهرت البيانات الكمية وجود فروق ذات دلالة إحصائية في التطبيق البعدي بين المجموعتين الضابطة والتجريبية تعزى لطريقة التدريس لصالح المجموعة التجريبية. أيضا توصلت الدراسة إلى عدم وجود أثر دال إحصائيًا للتفاعل بين طريقة التدريس ومتغير النوع الاجتماعي في التطبيق البعدي لمقياس الاندماج نحو التعلم. وتوصي الدراسة بأهمية تشجيع وتوجيه المعلمين والمشرفين والمختصين في مناهج العلوم بأهمية التوجه نحو تطبيق منحى التلعيب في حصص العلوم وتصميم المناهج والدروس وفق هذا المنحى وذلك لتحقيق أعلى مستوى من اندماج الطلبة في التعلم بشكل عام. الكلمات الدالة: منحى التلعيب، الاندماج في التعلم، تطبيق هاتفي

Introduction

Humans are the true wealth of any society, and upon them, human civilization is built. Interest has increased in the educational field with the factors affecting learning outcomes and associated with what happens in the classroom environment, such as engagement in learning. The concept of engagement in education is one of the motivational concepts that have an impact on students' achievement, attitudes, and motivation, and is a major contributor to school success in the short and long term (Desouki, 2020; Alsawaier, 2018).

Several studies have pointed to the effectiveness of the gamification approach in enhancing engagement in education (Alsawaier, 2018; Nand et al., 2019; Sailer et al., 2013; Wongso et al., 2014). Despite gamification in education being an emerging field, researchers have attempted to understand and discuss the effects of integrating game design elements (which are the foundation of gamification) into learning processes (Alsawaier, 2018; Dicheva et al., 2015). Gamification

relies on utilizing the rules and mechanisms of games and game design techniques in contexts unrelated to play as we know it (Alsawaier, 2018), with the aim of achieving goals that go beyond play and fun.

Therefore, this study aimed to identify the effectiveness of a mobile application based on the gamification approach in developing engagement in learning among eighth-grade students in the Sultanate of Oman. The COVID-19 pandemic has proven to us the need to use technologies and electronic applications to face emergencies, enabling the continuation of education outside the school walls in an interesting and attractive way for the student (Al Hosni & Al Balushi, 2023). The results of the current study, and its recommendations, will contribute to providing solutions based on modern technology applications in education, which can help raise the level of engagement in learning among students.

Theoretical Framework and Previous Studies

Engagement in Learning

From a theoretical perspective, engagement in learning is considered an important characteristic of an individual's personality due to its dynamic and social nature (Abdullah, 2017). It is also a tool for revealing academic achievement, as studies have indicated a correlation between achievement and academic engagement (Desouki, 2020; Fredricks et al., 2016). Engagement in learning reflects cognitive, emotional, and behavioral dimensions (Desouki, 2020), and is key to addressing a number of problems, such as feelings of boredom and anxiety among students, their feelings of alienation, and academic attrition (Desouki, 2020; Abdullah, 2017; Fredricks et al., 2016).

Despite the importance of the topic of engagement and the abundance of research on it, definitions of it remain unclear and inconsistent (Zhao et al., 2018; Wongso et al., 2014). The multidimensional nature of engagement is reflected in the multiplicity of its definitions in the research literature, which vary from one study to another and according to the purpose of the researcher (Al-Hajin, 2016). Initially, it was limited to academic engagement, but the literature has pointed out that the concept of engagement is a more comprehensive and broader concept, encompassing many dimensions (Alsawaier, 2018).

Engagement in learning is viewed as a multi-dimensional meta-structure, constantly redefined within social contexts and relationships between individuals (Desouki, 2020; Abdullah, 2017). However, numerous studies have concurred that it encompasses three primary dimensions: the psychological dimension, the cognitive dimension, and the behavioral dimension (Desouki, 2020; Abdullah, 2017; Fredricks et al., 2004). The latest model of engagement consists of four main dimensions: the cognitive dimension, the behavioural dimension, the emotional dimension, and the social dimension (Fredrick et al., 2016), which is the division that the current study will adopt. The following is a detail of the dimensions on which the current study is based:

- **Emotional Engagement:** Also known as psychological and emotional engagement (Desouki, 2020; Al-Hajin, 2016), it includes enjoyment and admiration for the school, a sense of belonging to it, a feeling of its value and importance, and the positive impact that the school creates in terms of happiness and pleasure (Desouki, 2020; Abdallah, 2017; Fredricks et al., 2016).

- **Behavioural Engagement:** It refers to the actions and practices that students perform in school during their learning process. This includes their commitment to rules and regulations, participation in curricular and extracurricular activities, flexibility in problem-solving, and serious participation by the student (Fredricks et al., 2016; Zhou et al., 2021).

- **Cognitive Engagement:** It is represented in what the learner achieves in terms of success in learning, and his ability to employ his knowledge in choosing learning methods, such as the ability to pay attention and concentrate. It is the students' self-organized method of learning, in which they use metacognitive strategies in planning, monitoring, evaluating knowledge, and managing and adjusting effort in academic tasks (Zhou et al., 2021).

- **Social Engagement:** This dimension was recently added in research to focus on engagement in small groups (Zhao et al., 2018). It is an act that establishes a model of relationships horizontally linked between community members, based on interaction with others and supporting them, participation, and exerting effort among all individuals involved in the interaction process (Desouki, 2020). Social engagement is achieved through respect for the feelings and rights of others,

respect for laws and regulations, teamwork, and listening to and following the teacher's instructions (Fredricks et al., 2016; Zhou et al., 2021).

The Gamification Approach

Numerous studies have pointed to the effectiveness of the gamification approach in increasing engagement in learning (Alsawaier, 2018; Nand et al., 2019; Sailer et al., 2013; Wongso et al., 2014). Simões and others have defined gamification (Simões et al., 2013: p. 12) as "the use of game design elements in non-game contexts, where most gamification applications rely on providing rewards or external reinforcement for certain activities". Gamification has been used in various fields of life, such as sports, health, and marketing, where people engage in a game-like activity to promote an activity, increase profits, or get a job (Sailer et al., 2013). In the field of education, the use of gamification has become widespread in a number of areas and for various purposes, such as: increasing motivation, engagement in learning, achievement, developing creative thinking, developing a tendency towards self-learning, and other areas (Al-Hosni and Al-Balushi, 2023; Alsawaier, 2018).

The components of the Gamification approach are derived from the Self-Determination Theory [SDT], which was developed by Deci and Ryan (Landers, 2015; Sailer et al., 2013). This theory is based on three main needs related to the internal psychological aspects of self-development, and the impact of environment on an individuals' motivation. These needs are the sense of connection (individuals' desire to feel that their deeds are valuable to the people around them), freedom of choice (humans' desire to feel responsible for making their personal decisions), and competence (individuals' need to feel able to achieve). Researchers acknowledge that these needs can be developed through good design of the gamification approach (Al Hosni et al., 2023).

Gamification and Engagement in Learning

Most educational uses of gamification aim to achieve long-term engagement in learning and achieve self-motivation, which is primarily based on meeting the psychological needs of students (Alsawaier, 2018). Referring to many studies that indicate the effectiveness of some elements of gamification in developing engagement, most studies have pointed to positive results about gamification

approach effectiveness in achieving engagement among regular students in general or students who find it difficult to engage in learning (Alsawaier, 2018; Barata et al., 2013; Sailer et al., 2017; Wongso et al., 2014).

Gamification elements provide a unique opportunity to achieve integration between the social, behavioural, cognitive, and psychological dimensions of engagement. The cognitive dimension is achieved when the student is given the opportunity to acquire knowledge when responding to game questions, when he receives direct feedback on his response, and when he is given several attempts to experiment and solve (Wongso et al., 2014). As for the psychological dimension, it can be achieved through the student's passion for progressing in the stages of the game, which results in positive attitudes towards the subject he is learning, eagerness to attend it, and a strong desire to participate in solving activities and games. The behavioural dimension can be observed through participation in solving activities and progressing in the stages of the game and obtaining badges. The effectiveness of gamification in achieving the behavioural dimension of engagement can be predicted, as what distinguishes gamification most is its ability to modify unwanted behaviour and develop the desired behaviour (Wongso et al., 2014). Researchers believe that this would contribute to achieving engagement among students in general and behavioural engagement in particular. We find that students make more effort to meet their essential needs and motivations (Barata et al., 2013). As for the social dimension, it is achieved when students compete together in the virtual rooms of the game, and in obtaining recognition for their achievements, represented in obtaining badges and advancing in the leaderboard or through cooperation or competition with others when progressing in the stages of the game (Wongso et al., 2014). Barata and others (Barata et al., 2013) pointed out that one of the most important elements that should be added when designing gamification is the element of social interaction, such as creating interactive groups for students, as the presence of social interaction elements helped to have positive feedback for teachers and students.

Study Problem

Educational literature indicates that many students in the middle stages of study face difficulties in engagement in learning, which negatively affects their

academic achievement (Alsawaier, 2018). Students who are engaged in learning participate more in classroom activities and interact better with teachers. In contrast, those who are not engaged do not participate in classroom activities and may exhibit inappropriate behaviors that lead to adverse results on their academic performance (Desouki, 2020; Abdallah, 2017). Engagement can also help prevent failure and reduce the achievement gap among students. It is one of the real keys to improving learning outcomes (Fredricks et al., 2016). The importance of engagement is highlighted as a state of positive emotional motivation for self-realization, which reflects on the individual's vitality and dedication to performing tasks (Al-Hajin, 2016).

Therefore, it was necessary to research the methods and strategies that could increase the level of engagement in learning among students. Several studies have pointed to the effectiveness of the gamification approach in achieving engagement among students (Alsawaier, 2018; Barata et al., 2013). Accordingly, the current study seeks to investigate the effectiveness of a mobile application based on the gamification approach in raising the level of engagement in learning for eighth-grade students in general, with a specific focus on social, emotional, and behavioural engagement.

The Study's Objective and Questions

The current study sought to investigate the effectiveness of an innovative mobile application based on a gamification approach in enhancing the level of engagement in learning among eighth-grade students. The study aims to answer the following main research question:

What is the impact of teaching using a mobile application based on a gamification approach on the level of engagement in learning among eighth-grade students in the Sultanate of Oman?

From the main question, the following research questions are derived:

1. What is the impact of teaching science using an innovative mobile application based on a gamification approach on the level of engagement in learning among eighth-grade students?

2. What is the nature of the interaction between the teaching method (gamification approach/traditional method) and the social type (male/female) on the level of engagement in learning among eighth-grade students?

Significance of the Study

This study derives its importance from:

1. The novelty of using gamification in education as one of the most important modern trends in the field of mobile learning-based educational technology.
2. It evidenced effectiveness in continuing education during crises such as COVID19 pandemic, as well as in online learning (Al Hosni & Al Balushi, 2023).
3. The current study aims to direct teachers' attention in the Arab world to employ the gamification approach to teach science.

Study justifications:

1. Recommendations of several studies to the necessity of engagement in learning, such as (Alsawaier, 2018; Barata et al., 2013).
2. This study contributes to the recommendations of several previous studies to apply the gamification approach in several fields, as in (Al Hosni & Al Balushi, 2023; Al Hosni et al., 2023; Al Shammari, 2019; Hursen & Bas, 2019; Al Shammari, 2020)
3. Rare Arabic and foreign studies in this field, since the current study is the first, as to researchers' knowledge, in the Arab world in general, and in the Sultanate of Oman in particular, that shed light on designing a mobile- based application on the gamification approach that help develop learning engagement for school students, leading the way for other studies to investigate the effectiveness of modern methods on learning and students' needs, generally, and learning engagement particularly.

First: study subject limits

The study subject is limited to:

- A mobile application based on the gamification approach designed by the researchers and developed by a programming company specialized in programming and designing gamification based – applications. The application is named (Dr. science 2). It is an advanced version for grade 8 students of the (Dr. Science), which was designed by Al Hosni (2023) for grade 4 students.
- Measuring the effect of the gamification approach in developing grade 8 students' learning engagement in the Sultanate of Oman.
- The study is applied on most of semester one science curriculum topics for grade 8 in the Sultanate of Oman, which are (plants, elements and compounds, light, food and digestion, material changes).

Second: Study time limits

- The study was applied in semester one of the academic year 2022-2023

Third: study spatial limits

- The study was applied in a cycle 2 school (grades 5-10) of the General Directory of Education in the Governorate of Muscat

Fourth: sample limits

- Male and female grade 8 students

Study limitations

Study limitations include the lack of available devices for all students, in addition to the slow network in the schools to which the study was applied. These issues are solved by providing devices for students, and network boosters in the schools.

Study terminologies

The study includes a set of terms that the researchers believe should be defined according to the context of the study procedures. The terms are:

Engagement in learning: “the psychological investment and effort directed to learning, understanding and mastery of knowledge, as well as the student’s feeling of belonging to the school, acceptance of its values, and positive participation in its activities” (Schernoff et al., 2003, p. 159). This study defines learning engagement as the amount of time and the physical and psychological

energy spent by eighth-grade students in the learning process, through accessing the mobile application, answering questions, interacting with colleagues, and feeling the desire to learn and enjoy learning. Engagement is determined by the degree that students obtain by responding to the learning engagement scale that this study applies, which includes three dimensions; behavioral, psychological, and social.

Learning by gamification: it is defined by Ouariachi et al. (2020, P2) as “the application of game-design elements in non-game contexts...as a strategy that can positively engage people in behavioral change”. The current study defines it as learning by using a mobile application that incorporates the main elements of a game, (such as collecting points, leaderboards, levels, badges, nicknames, etc.), in an educational context containing a large number of questions and activities on science topics appropriate for eighth graders.

Method and Procedures

Study Approach and Design

The study utilized a quasi-experimental methodology, incorporating a design that included two distinct groups: a control group and an experimental group. Both groups were evaluated using the engagement in learning scale prior to the experiment. Subsequently, the experimental group received instruction through a play-based approach, while the control group was taught using the conventional method. Following the instructional period, the engagement in learning scale was reapplied to both groups.

Study Community and its Sample

The study sample was intentionally selected from the study community, which is the eighth grade in Muscat Governorate in the Sultanate of Oman. A school for males and a school for females were chosen due to the cooperation of the school administration and the presence of an appropriate electronic environment for conducting the study and using the mobile application. Four sections from the eighth grade were chosen, with an average of two sections from female schools and two sections from male schools randomly, with a total of 124 male and female students. They were randomly distributed into experimental and control groups. Table 2 illustrates the distribution of the study sample.

*Table 2**Distribution of sample members by number of tribes and social type*

Group	Number of Sections		Number of Students	
	Males	Females	Males	Females
Experimental	1	1	31	31
Control	1	1	32	30
Total	2	2	62	62

Study Tools and Materials

An engagement in education scale was used, and a mobile application based on the gamification approach was developed and used for the experimental group. A teacher's guide was also prepared to assist in using the mobile application in the experimental group. Below is a detailed explanation of the study tool and its materials.

Study Tool

Engagement in Education Scale: The researchers used a behavioural, emotional, and social engagement scale prepared by Zhao et al., 2018. This scale is a shortened version of a longer scale prepared by Van Damme et al., 2002. The researchers chose this scale due to its scientific accuracy and the appropriateness of its phrases for the age group of the students, who are in the eighth grade. The researchers developed some phrases to suit the circumstances of the study. The final version of the scale consists of 21 phrases answered using a five-point Likert scale (strongly agree, agree, neutral, disagree, strongly disagree). It consists of three axes, which are:

- Emotional Engagement: This axis focuses on the students' feelings in general, such as enjoying learning, admiring the science class, feeling a sense of belonging to it, and feelings of joy, happiness, and enthusiasm that fill the

student while learning science. Phrases in the scale about this axis include “I enjoy the science class” and “I feel happy when carrying out activities in the science class.”

- Behavioural Engagement: This axis focuses on the behaviors and actions that the student performs in the science class in particular, such as commitment to the teacher, follow-up, conducting experiments, responding to the teacher, and keenness to successfully conduct the class. Phrases in the scale about this axis include “I engage with the investigative and exploratory activities in the science class” and “I often chat with my peers about things outside the lesson topic in the science class.”
- Social Engagement: This axis focuses on interaction and participation among members of the same team in group work, comfort, and happiness when working in the team, working with the spirit of one team, with respect and appreciation for each individual in the team. Phrases in the scale about this axis include “I feel comfortable working with my peers in the science class” and “My peers help me when I ask them in the science class.”
- Scale Validity: The validity of the scale was verified and its suitability for the Omani environment was ensured in two ways:
 - Judges’ Validity: After reviewing and developing the scale, and to ensure its suitability for the age group, which are eighth-grade students, and its suitability for the Omani environment, it was sent to 6 specialized judges with experience to express their observations about the scale. Adjustments were made in light of the received observations, which were summarized in modifying some linguistic formulations to be clearer and more suitable for the axis to which they belong.
 - Internal Consistency: The internal consistency of the scale was verified by calculating the Pearson Correlation coefficient between each phrase and the total

score of the scale as shown in Table 3, and between each axis and the total score as shown in Table 4, after applying it to a survey sample of 25 male and female students from the eighth grade outside the study sample.

Table (3)

Correlation coefficients between the scale phrases and the total score of the scale and their significance

Statement	Coefficient	Statement	Coefficient	Statement	Coefficient
1	0.54*	9	0.55*	17	0.59*
2	0.60*	10	0.65*	18	0.63*
3	0.56*	11	0.79*	19	0.71*
4	0.50*	12	0.43*	20	0.57*
5	0.71*	13	0.54*	21	0.60*
6	0.41*	14	0.44*		
7	0.47*	15	0.54*		
8	0.45*	16	0.67*		

*Significant at the 0.05 level

Table (4)

Correlation coefficients between the scale axes and the total score of the scale and their significance

	First Dimension	Second Dimension	Third Dimension	Total
First Dimension	-	0.90*	0.69	0.93
Second Dimension		-	0.66*	0.92
Third Dimension			-	0.88*

*Significant at the 0.05 level

It is clear from the table that all correlation coefficient values are positive and significant at the 0.05 level. In addition, the correlation coefficient values ranged between 0.44 and 0.71. The correlation coefficient values between the scale axes and the total score of the scale ranged from 0.66 to 0.93. Based on the interpretation of correlation coefficients provided by Guilford (1956), all

correlation coefficients are considered medium or strong. Also, all values are acceptable in educational circles (Ibrahim, 2017).

- **Scale Reliability:** The reliability coefficient was calculated using Cronbach's alpha. The final result for the scale reliability was 0.88. Table 5 shows Cronbach's alpha coefficient for each axis of the scale, which are considered acceptable in educational circles (Al-Nabhan, 2004, p. 240).

Table (5)

Values of the reliability coefficient using Cronbach's alpha for the entire scale and for each axis of the engagement in learning scale

Axes	Number of Statements (Their Numbers)	Cronbach's Alpha Coefficient
First Axis (Psychological Integration)	7 (1-7)	0.70
Second Axis (Behavioral Axis)	7 (8-14)	0.73
Third Axis (Social Integration)	7 (15-21)	0.82
The Scale as a Whole	21 (1-21)	0.88

The Mobile Application

The mobile application implemented in the study is (Dr. Science 2); an advanced version of the mobile application (Dr. Science) that was designed by Al Hosaniyah (2023). Both applications were designed according to the general model of educational design (ADDIE Moodle), which consists of five phases: analysis, design, development, implementation, and evaluation. The application interfaces and questions were prepared based on the phases as follows:

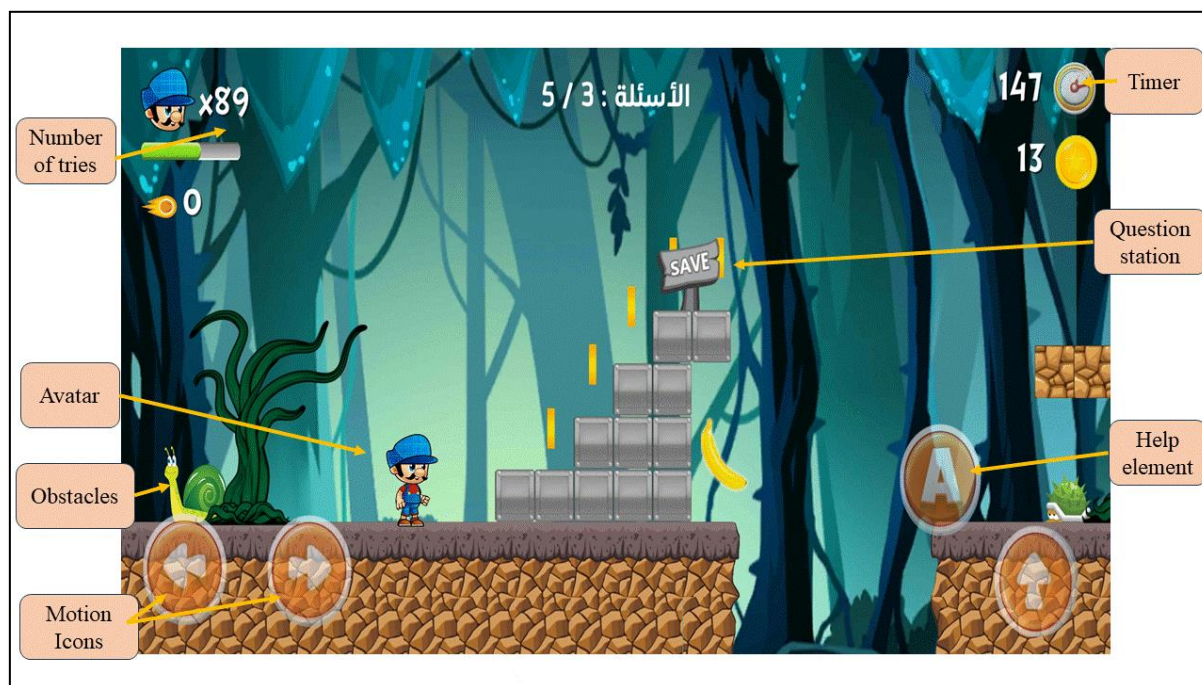
- Phase one (Analyze): at this phase, the general goal of the mobile application is specified, in addition to the educational goals and study units for grade 8 in semester one, which content will be designed on the application.
- Phase two (Design): an important phase during which a general outline for the application that includes a plan for how the program is designed and designing the interfaces. The application consists of the most important elements for

gamification mentioned in education literature, which are; points counter, progress bar, points store, board of honor, and list of badges. Below is a simplified explanation of the most important elements:

- Points Store: in this part, the student exchanges the points collected for a gift from the Points Store. The gifts are represented in 3 electronic cards in the application (green, silver, and gold cards). The student exchanges electronic cards for gifts from the teacher.
- Board of honor: in this board, 20 students are ranked in descending order according to the number of points they obtained, from first place (highest in number of points) to twentieth place (lowest in number of points). Students' ranking changes according to the number of points they obtain daily.

The application also includes a section (I am a genius) which contains a large set of questions that the student answers in a series of adventures in the form of a fun-filled game, as shown in Figure 1.

Figure 1
figure (1) shows "I am a genius" in (Dr. Science 2) application interface.

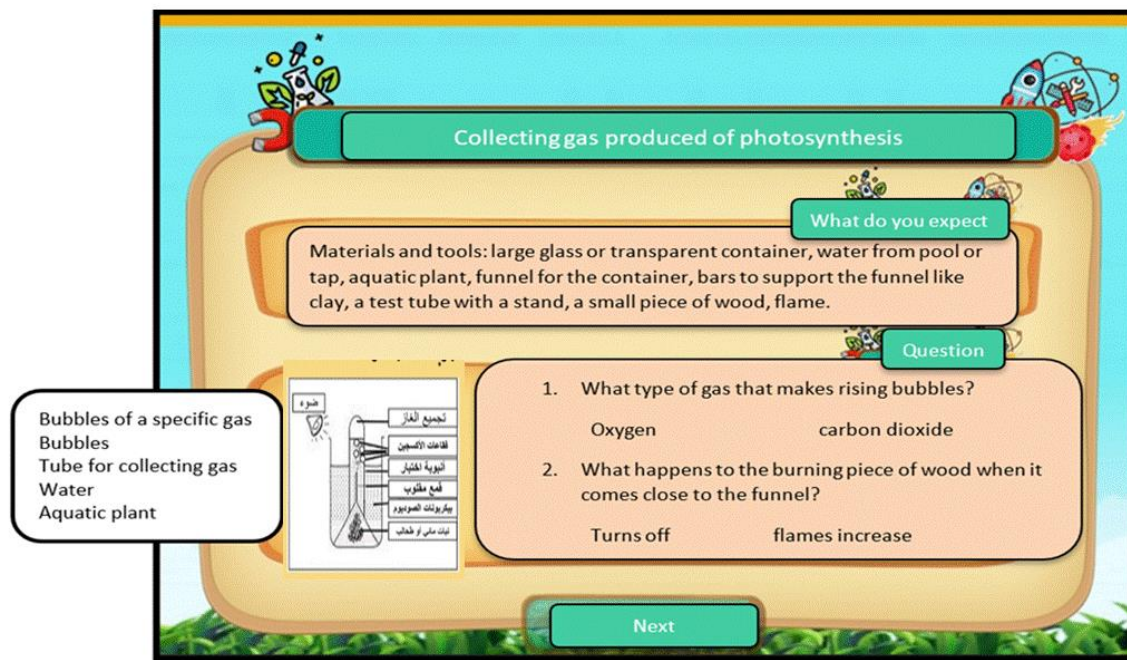


The application consists of a section (I Explore) which includes 20 scientific investigations from the topics in the curriculum. These investigative experiments

have been developed in the eighth-grade curriculum and introduced into the mobile application. They have been modified so that the student can conduct the experiment in the classroom and enter the results into the mobile application, following a distinctive scientific methodology. The stages of conducting the experiment are divided into 5 steps: the title of the experiment, what do you expect (predict), conducting the experiment, the young researcher (questions with higher abilities), and what you learned (a general summary of the experiment). Figure ٢ shows the interface of what do you expect in the application (Dr. Science٢).

Figure ٢

“what do you expect” in (Dr. Science 2) application



Third stage, Development: In this stage, the interactive interfaces were collected and integrated into a mobile application, adding motion effects and sounds and verifying that the application works well and smoothly.

Fourth stage, Application: This stage begins by presenting the mobile application to programming companies to verify its effectiveness, in addition to conducting a survey by presenting it to a group of 1٠ students in grade eight, to

test the application and give feedback, in addition to presenting it to a group of eighth-grade teachers to give feedback on the mobile application.

-Fifth stage, Evaluation: it is the last phase in the general model in which an evaluation is produced on the validity of the gamification-based application. the study results and their interpretation will be the completion of this stage.

Equivalence between the two groups:

To verify the equivalence of the experimental and control groups in the pre-measurement of the level of school engagement, the "t" test for independent samples was used to know the differences and their significance between the two groups and Table 6 shows these results.

Table (6)

Results of the "t" test for independent samples to verify the equivalence of the experimental and control groups in the pre-measurement of the level of engagement in learning.

Variable	Group	Number	Mean	Standard Deviation	t Value (df=122)	Significance Level
Behavioral Engagement	Experimental	62	3.64	0.67	0.020	0.984
	Control	62	3.64	0.63		
Emotional Engagement	Experimental	62	3.20	0.47	0.127	0.899
	Control	62	3.21	0.54		
Social Engagement	Experimental	62	3.67	0.71	0.878	0.382
	Control	62	3.56	0.65		
Level of Engagement in Learning	Experimental	62	3.50	0.47	0.355	0.723
	Control	62	3.47	0.48		

* Significant at the significance level ($\alpha = 0.05$)

It is clear from Table 4 that there are no statistically significant differences between the experimental and control groups in the pre-measurement of the level of engagement in learning. The probability value (t) was greater than the significance level ($\alpha=0.005$), indicating that the two groups are equivalent at the start of the application of the teaching strategy using a mobile application based on the gamification approach.

Procedures for Applying the Study

1. Developing the mobile application (Dr.science), which was designed by Al Hosaniyah (2023), and producing a new version of it named (Dr.science 2), since (Dr.science) was targeted for fourth graders, whereas (Dr.science 2) targets eighth graders. Basic, while the target group in the developed application (Dr.science 2) are eighth grade students.

2. After preparing the theoretical framework and the actual version of the application, teachers involved in the study were given a training workshop, who numbered one male teacher from the male group and one female teacher from the female school. They were trained over three days on how to use the (Dr. Science2) application before starting the study application. The students were trained on how to use the application in the first two days of the study application.

3. The engagement scale was applied to the students beforehand, before starting the project implementation on both the control and experimental groups.

4. Providing devices and tablets with the application to all male and female students in the two schools and providing network boosters in the schools in which the study is applied.

5. The study application extended for 12 weeks during the first semester of the academic year 2022/2023, including the pre and post applications of the engagement scale in learning.

6. The process for applying the study was that the teacher explains the lesson topic in the first part of the lesson, then students are allowed to apply what they have learned in the second part of the lesson using (Dr. Science2 application) in class, and during spare time at school or at home and during holidays.

7. After the completion of the experimental application of the study, the engagement scale in learning was applied to the two study groups again.

Data Analysis

The following statistical treatments were used to analyze the quantitative data:

1. To calculate the stability of the scale, the Alpha Cronbach stability coefficient was used.
2. The internal consistency of the scale was verified by calculating the correlation coefficient (Pearson Correlation) between each phrase and the total score of the scale.
3. To ensure the equivalence of the control and experimental groups before starting the study application, by calculating the arithmetic averages and standard deviations, and using the "t" test (Independent sample test) for the two independent samples to calculate the significance of the differences for the control and experimental groups in the engagement variable.
4. To know the effect of the gamification approach in developing engagement among students, the analysis of common variance (ANCOVA) was used in calculating the significance of the differences between the arithmetic averages in the two groups.
5. To verify the interaction between the teaching method (gamification approach / prevailing method) and the social type (male / female) in engagement in learning among eighth-grade female students, the analysis of common variance (ANCOVA) was used in calculating the significance of the differences between the arithmetic averages in the two groups.

Study Results and Discussion

Results of the first question: What is the impact of teaching science using a mobile application based on gamification on the level of engagement in learning among eighth-grade students?

To determine whether there is an impact of teaching using a mobile application based on gamification on the level of engagement in learning, the analysis of covariance (ANCOVA) was used to identify the differences between the experimental and control groups in the post-measurement of the level of

engagement in learning after adjusting the effect of the pre-measurement. Table 7 illustrates the arithmetic means, standard deviations, and adjusted means.

Table 7

Arithmetic means and standard deviations of the study group results in the post-application of the engagement in learning scale after adjusting the effect of the pre-measurement

Scale Axes	Teaching Method	Number (n)	Arithmetic Mean	Standard Deviation	Adjusted Arithmetic Mean
Behavioral Engagement	Experimental	62	4.28	0.50	4.28
	Control	62	3.96	0.62	3.96
Emotional Engagement	Experimental	62	3.97	0.64	3.73
	Control	62	3.70	0.75	3.57
Social Engagement	Experimental	62	3.73	0.36	3.73
	Control	62	3.56	0.54	3.57
School Engagement Level	Experimental	62	4.00	0.36	3.99
	Control	62	3.74	0.50	3.74

Table 8 also shows a summary of the results of the accompanying variance analysis for the differences between the experimental and control groups in the post-measurement of the level of engagement in learning after adjusting the effect of the pre-measurement.

Table 8

Results of the accompanying variance analysis to identify the differences between the experimental and control groups in the post-measurement of the level of engagement in learning after adjusting the effect of the pre-measurement

Scale Axes	Variance Source	Sum of Squares	Degrees of Freedom	Mean Square	F	Significance Level	Effect Size (η^2)
Behavioral Engagement	Pre-measurement	1.76	1	1.76	5.77	0.018	0.05
	Teaching Method	3.33	1	3.33	10.89	0.001	0.08
	Error	36.97	121	0.31			
Emotional Engagement	Pre-measurement	6.76	1	6.76	15.38	0.000	0.11
	Teaching Method	2.42	1	2.42	5.51	0.021	0.04
	Error	53.20	121	0.44			
Social Engagement	Pre-measurement	0.24	1	0.24	1.13	0.289	0.01
	Teaching Method	0.80	1	0.80	3.79	0.054	0.03
	Error	25.45	121	0.21			
Learning Engagement	Pre-measurement	1.63	1	1.63	9.26	0.003	0.07
	Teaching Method	1.95	1	1.95	11.09	0.001	0.08
	Error	21.30	121	0.18			

It is clear from Table 8 that there are statistically significant differences in the post-measurement for all axes of the school engagement scale after adjusting the effect of the pre-measurement according to the teaching method variable. Returning to the arithmetic means, it is clear that these differences were in favor of the students of the experimental group in all axes, and the value of the effect size eta for the scale as a whole (η^2) = (0.08), and the effect size that the training program caused is considered medium with its approach to the large level; as Cohen (1988) indicated that the effect size is considered medium if its value is between (0.06-0.14) and is considered large if its value exceeds (0.14), and we conclude from this that teaching using a mobile application based on gamification has contributed to raising the level of school engagement among students.

Researchers believe that this result can be explained in light of the Self-Determination Theory (SDT) on which gamification is based (Landers, 2015; Sailer et al., 2016). We find that the good design of the application helped to meet many of the student's needs. The student feels competent when he advances on the leaderboard and through badges, points, and moving between levels, feels connected through competitive relationships, and the desire to lead, and feels independence through his freedom to play and choose the appropriate place and time for him, all of which can develop their engagement. Many studies have confirmed the effectiveness of gamification elements if they are well designed (Alsawaier, 2018; Dicheva et al., 2015), and the good design of gamification elements, and their precise employment is of great importance because it can affect many of the psychological needs of students (Hanus & Fox, 2015), and the current application was designed based on the recommendations of many studies such as (Aldemir et al., 2018).

Looking at the axes of engagement, the results indicate the growth of behavioral engagement in the scale, which can be explained as a result of the characteristics of gamification, where the student is committed to entering the application and solving activities, synchronized with direct reinforcement and immediate feedback, which pushes them to make more effort to solve activities at home and school. As for psychological engagement, we find that the student's desire to play synchronized with getting appreciation through badges and leaderboards, in

addition to the prevailing atmosphere in the application, which is an atmosphere of challenge, joy, and enthusiasm helped in developing the psychological engagement of students. As for social engagement, it is expected that it has grown due to the characteristics of the application based on working in the spirit of one team in solving practical projects in the section (I explore) in the application, and on task distribution and joint work, to get the same result. The result of the current study agrees with many studies that pointed to the effectiveness of gamification in developing engagement in learning among students such as (Alsawaier, 2018; Nand et al., 2019; 2020; Sailer et al., 2013; Wongso et al., 2014).

Results of the second question: What is the nature of the interaction between the teaching method (gamification / the prevailing method) and the social type (male / female) in the level of engagement in learning among eighth-grade students?

To determine whether there is a statistically significant effect of the interaction between the teaching method (gamification / the prevailing method) and the social type (male / female) in engagement in learning among eighth-grade students; The two-way accompanying variance analysis (Two way-ANCOVA) was used, and Table 9 shows the arithmetic means and standard deviations of the two groups that studied the gamification method and the prevailing method in the post-measurement of school engagement according to the variable.

Table 9

Arithmetic means and standard deviations of the learning engagement scale for the students of the two study groups according to the social type variable among eighth-grade students.

Scale Axes	Teaching Method	Social Type	n	Arithmetic Mean	Standard Deviation
Behavioral Engagement	Gamification	Male	31	4.06	0.51
		Female	31	4.50	0.40
		Total	62	4.28	0.50
	Traditional	Male	32	3.80	0.56
		Female	30	4.12	0.65

		Total	62	3.96	0.62
	Total	Male	63	3.93	0.55
		Female	61	4.32	0.56
		Total	124	4.12	0.58
Emotional Engagement	Gamification	Male	31	3.69	0.69
		Female	31	4.26	0.45
	Traditional	Total	62	3.97	0.64
		Male	32	3.48	0.65
		Female	30	3.93	0.79
		Total	62	3.70	0.75
	Total	Male	63	3.58	0.67
		Female	61	4.10	0.66
		Total	124	3.84	0.71
Social Engagement	Gamification	Male	31	3.74	0.34
		Female	31	3.73	0.38
	Traditional	Total	62	3.73	0.36
		Male	32	3.43	0.62
		Female	30	3.71	0.42
		Total	62	3.56	0.54
	Total	Male	63	3.58	0.52
		Female	61	3.72	0.40
		Total	124	3.65	0.46
Learning Engagement Level	Gamification	Male	31	3.83	0.38
		Female	31	4.16	0.24
	Traditional	Total	62	4.00	0.36
		Male	32	3.57	0.45
		Female	30	3.92	0.50
		Total	62	3.74	0.50
	Total	Male	63	3.70	0.43

Female	61	4.04	0.40
Total	124	3.87	0.45

As Table 10 illustrates, it presents the results of the accompanying binary variance analysis to understand the impact of the interaction between the teaching method (playful approach/traditional method) and the social gender (male/female) on the engagement in learning among the eighth-grade students.

Table 10

Results of the binary variance analysis for the interaction between the teaching method (playful approach, traditional method) and the social gender (male/female) in the engagement in learning among the eighth-grade students.

Scale Axes	Variance Source	Sum of Squares	Degrees of Freedom	Mean Square	F	Significance Level	Effect Size (η^2)
Behavioral Engagement	Pre-measurement	0.64	1	0.64	2.28	0.134	-
	Teaching Method (A)	3.22	1	3.22	11.44	0.001	0.09
	Social Type (B)	3.47	1	3.47	12.32	0.001	0.09
	Interaction (A) \times (B)	0.03	1	0.03	0.12	0.733	-
	Error	33.49	119	0.28			
Emotional Engagement	Pre-measurement	5.73	1	5.73	14.85	0.000	0.11
	Teaching Method (A)	2.27	1	2.27	5.89	0.017	0.05
	Social Type	7.20	1	7.20	18.6	0.000	0.14

	(B)			5			
	Interaction (A) × (B)	0.03	1	0.03	0.08	0.771	-
	Error	45.95	119	0.39			
Social Engagement	Pre-measurement	0.59	1	0.59	2.96	0.088	0.02
	Teaching Method (A)	0.70	1	0.70	3.50	0.064	-
	Social Type (B)	0.70	1	0.70	3.46	0.065	-
	Interaction (A) × (B)	0.86	1	0.86	4.26	0.041	-
	Error	23.94	119	0.20			
Overall Level of School Engagement	Pre-measurement	1.42	1	1.42	9.43	0.003	0.07
	Teaching Method (A)	1.86	1	1.86	12.34	0.001	0.09
	Social Type (B)	3.24	1	3.24	21.54	0.000	0.15
	Interaction (A) × (B)	0.11	1	0.11	0.71	0.400	-
	Error	17.93	119	0.15			

From Table 10, it is clear that there is no statistically significant effect of the interaction between the teaching method (game-based approach, prevailing method) and the social type in all the sub-axes of school engagement and at the level of the total grade for eighth-grade students. This means that the teaching method did not affect males differently from females. Therefore, it can be

inferred that learning using the Dr. Science2 application is suitable for enhancing the engagement of male and female students in learning equally. This study agrees with the study of Fah et al. (2016), which indicated that the difference between the engagement of the two genders was not significant when it comes to learning through gamification. The current result differs from the study (Wang et al., 2011), which pointed to differences between the genders in both behavioral and cognitive engagement.

Summary and Recommendations

The current study aimed to investigate the effect of a game-based mobile application approach in raising the level of engagement in learning in general, and behavioral, psychological, and social engagement in particular, among eighth-grade students in Oman. The study resulted in a set of results, including the superiority of the experimental group that studied using the game-based approach over the control group that studied with traditional methods. The study also found that the effect of the game-based approach using the Dr. Science2 application in engagement in learning in general and in its three axes: behavioural, psychological, and social engagement, does not differ according to the social type of the learner.

Among the reasons that may have contributed to the success of the experiment is the good design of the game-based application, which is unique in presenting homework and practical projects, as the student chooses the appropriate time and place for him to complete the tasks. Good design of game elements and their precise employment is extremely important as it can affect many of the psychological needs of students (Hanus & Fox, 2015), and the current application was designed based on the recommendations of many studies such as (Aldemir et al., 2018).

As for the determinants of the study, the researchers believe that they are represented in the withdrawal of some students, so they were excluded from the study sample. Also, one of the determinants is the increased pressure on the network due to the use of a large number of devices at the same time, which led to the application's initial slowdown. This problem was solved by providing four network boosters distributed to the implementing schools.

Considering the above, the study recommends the following:

1. Prepare courses and training workshops for teachers and supervisors on the mechanism of lesson planning and the application of programs based on the game-based approach and its use in teaching. With the emphasis that game elements do not necessarily have to be virtual, they can be real and applied by the teacher in the classroom.
2. Conduct studies to develop a comprehensive understanding about the effectiveness of the gamification approach on students' interaction and engagement, and to research the most effective components of game elements that can create suitable conditions to increase engagement in learning.

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