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Exploring teachers' perspectives on using gamification in teaching science in Saudi Arabia

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ABSTRACT

This study explores utilizing gamification in teaching science at the school level in Saudi Arabia. Towards this end, a mixed-method approach, viz. parallel convergent, was adopted to collect data from a sample of teachers (n=200) via a questionnaire and an interview. The questionnaire encompassed two parts. The first part elicits information about the teachers. The second comprised 36 items making the three areas of the investigation-importance, use, and obstacles. Besides the questionnaire, six teachers were interviewed for an in-depth understanding of the findings surfaced from the questionnaire. Descriptive statistics yielded actual results, at the top of which the teachers' favorable view of gamification in science lessons. They use gamification to a moderate degree in their teaching due to some obstacles, ranging from medium to high. The obstacles, administrative-based and teacher-related, led to reduced gamification uses. The statistical analysis of the data probed through a questionnaire identifies the variation in the informants' responses according to their specializations, qualifications, and teaching experiences. Data elicited from the interviews reinforced such statistical findings that concluded showing no statistically significant differences between their responses at the level of significance ($\alpha \leq 0.05$).

1. Introduction

Science plays a vital role in all fields of life. It has a remarkable role in most scientific and technical progress. Obviously, science is present everywhere and constitutes an essential part of our lives and future. Hence, it is crucial to focus on science learning and teaching, especially in primary school, to develop pupils' mental faculties, expand their perceptions, experiences, and scientific concepts, and prepare them for the other scientific subjects in the advanced stages.

Science is foundational for various scientific subjects. It promotes in-depth understanding and deduction, bridges between different branches of science. Taber (2017) advocated that it helps learners discover new scientific applications and develops their intuition, imagination, and thinking. It also trains them in practical scientific experiments to hone their abilities and prepare them for professional life. It provides learners with an appropriate amount of biological knowledge in a functional manner that contributes to scientific culture and scientific knowledge, including facts, concepts, principles, laws, and scientific theories. That is, it helps learners acquire and develop appropriate mental skills and abilities.

Science teachers' current teaching trends go beyond recitation and indoctrination, memorization, and retrieval, which make the student's role negative during the lesson. Dikli (2003) indicated that current teaching practices in several contexts focus on information using traditional methods and strategies that depend on memorization. The focus is on the knowledge itself without exploring learners' mental potentials. Traditional teaching methods limit learners' innovations and thinking abilities and reduce their motivation to study science.

Güneş (2020) advocated that the increased educational materials and usual teaching methods that call for memorization and indoctrination demotivate students to learn and weaken their enthusiasm. Add to that their inability to persevere and exert effort, the low level of teaching and learning sciences, and the difficulty of following up on scientific information by learners.

Memorization-based teaching methods, recitation, and memorizing scientific facts without

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understanding the connections between them and disregarding individuals' differences widen the gap between the sciences taught in school and learners' daily lives. It has decreased their motivation, caused negative attitudes toward learning science, and gave way to boredom, poor academic achievement, and the belief that science subjects have no real-life applications beyond the school walls (Lee, 2019). This was demonstrated by the results of the International Trends in Mathematics and Science Study (TIMSS). The Kingdom of Saudi Arabia ranked 37 out of 43 participating countries with a rate of 368 points out of 500 points. It was classified as one of the lowest countries in the world (Smiderle et al., 2020).

Recent years have witnessed rapid development and massive knowledge explosion, necessitating this worldwide progress, especially in technology. Technology has become a fundamental requirement of the time, specifically in the educational process, to benefit from and employ it to satisfy educational purposes and achieve its goals.

One of the recent trends in teaching is the use of educational games. They increase learners' motivation and enhance interaction with the scientific material presented entertainingly and enjoyably to achieve the desired goals (Filgona et al., 2020). That is to say, learners become more positive in the learning process than in other educational means (Smiderle et al., 2020). Modern education emphasizes fun in students' life, giving way to games and educational activities. They have become an integral part of the curricula. The teacher plays a crucial role in exploiting games and employing them in teaching. Gaming is a crucial educational mediator informing individuals' personalities at all stages. It has gained this importance from its significant role in the psychological formation of the individual. It helps them learn self-control to harmonize and adapt to the group and laws. It also helps them recognize things, categorize concepts, and increase linguistic growth (Lee, 2019). Educational games are a primary entry point for the growth of learners' mental, physical, social, moral, skill, and linguistic aspects. They also allow the discovery of the relationships between them. They form a critical factor in developing achievement and thinking in various forms and help learners get rid of stress and negative emotions (Lee, 2019; Smiderle et al., 2020).

With the development of life and human sciences, educational games developed and changed remarkably. The game-based tools were also developed. After the tools were limited to traditional tangible games and the materials available in nature only, new tools appeared based on modern technology in education. Electronic devices and computers are working examples. In the world of educational games, digital educational games. This development and shift towards integrating educational games with electronic technology attracted much attention, especially after widespread electronic devices.

With significant technical development, educational strategies and theories have evolved. It has become necessary to use methods and techniques that suit learners and their needs in the twenty-first century–gamification is a working example. It attracts students' attention and increases their motivation (Dikli, 2003; Filgona et al., 2020). This is because it attractively and interestingly provides interactive opportunities for teaching, learning, and game-enabled skills. These skills could be in the form of information or activities presented via the web, smart devices, or the computer. Smiderle et al. (2020) believed that gamification provides students with twenty-first-century skills and the skills of research and exploration.

Many studies set gamification apart from other teaching strategies showing its numerous benefits in teaching and learning (Rincon-Flores et al., 2022). For instance, Dichev and Dicheva (2017), Filgona et al. (2020), and Smiderle et al. (2020) mentioned some of those benefits: Increased participation and effectiveness of learners. Competitive games attract learners' attention and motivate them, given that they strive to achieve a particular goal. Arguably, when learners feel optimistic about their learning and know that they are rewarded for their effort. They become active, rather than passive, participants. The result is that they tend to retain information in long-term memory. In this way, their gamification-based knowledge is linked to their preferred experience provided by competitive games (Ibanez et al., 2014). Another benefit relates to the clarity of educational goals. Loos and Crosby (2017) stated that clear educational goals and implementation steps are standard features of gamification-based activities. This contributes to achieving those goals properly. Simply implementing the basic gameplay is simple and has many benefits. The most important advantage lies in how a gamification activity is designed. The teacher must choose the most appropriate play elements and set clear goals for the learners to acquire presentation methods and teaching steps. Brophy (2015) asserted that gamification develops thinking skills, the ability to link the lesson with previous experiences and develops the social aspect of students by enhancing cooperation and teamwork and encouraging students to help each other. Hence, it increases their understanding and learning. Failure in gamification does not mean the end, but rather an opportunity to teach and advance knowledge, so the learner can try different and develop problem-solving skills.

Another benefit includes motivation (Chevtchenko, 2013; Grant et al., 2014; Chou, 2019). Rincon-Flores et al. (2021) stated that motivation is used for effective specific educational achievements. It is to be considered one of the student's ability achievements determinants related to learners' needs and desires. Some stimuli reinforcements affect learners' behavior and urge them to persevere and work actively and effectively. Therefore, motives significantly impact the education process, so there is no learning without motivation.

Gamification in the educational process helps achieve several advantages. For example, medals enhance learners' motivation and modify their behaviors into positive ones, thus completing the goals of utilizing gamification. It is common sense that the points make the educational experience more enjoyable and motivating for learners. The progression element helps to show the individual's mastery of the skill required to be acquired and thus motivates learners to complete educational activities and duties. Gamification should be employed appropriately to yield positive results in the educational process (Araújo and Carvalho, 2022).

Despite the advantages of gamification in teaching and learning, some obstacles hinder its effective use, e.g., misunderstanding of the concept of gamification. It is the use of play ideas and their mechanism in contexts other than play to urge participants to participate that develops their skills in a field. This problem can be explained in light of the confusion in the definition of gamification.

Among the obstacles to gamification is poor or inadequate implementation. This, in turn, leads to tension in the classroom and chaos, thus reducing learning and wasting time (Araújo and Carvalho, 2022). Dichev and Dicheva (2017) indicated that one content is not suitable for all Learners, many designers of educational programs based on gamification rely on a single game that has proven to be successful in teaching a course, regardless of its content and content, which may not be in line with learners' needs and course objective.

Brophy (2015) went a step further that one of the negative aspects of gamification and the competitive nature of gaming systems may cause anxiety for students and increase their feeling of inadequacy. In addition, managing and treating gamification systems and following up on results increases teachers' workload. The challenges facing gamification adopters can be overcome by designing educational programs based on gamification. The mechanisms of playing serve the educational process and analyzing the actual needs to know the characteristics of the target group and the needs of the learners. Additionally, careful awarding and prize-giving link awards to outstanding performance, give privileges to students who cooperate with their peers, and honor students who repeatedly try to overcome difficulties and achieve the best results. Add to that training programs for teachers to use gamification effectively and hold meetings between teachers who apply the method to exchange experiences.

2. Research questions

Touched on the above, the following questions determine the problem the study undertakes:

- What is the importance of gamification in teaching science from the teachers' viewpoints in Saudi Arabia?
- What is the extent to which they believe gamification is implemented in Saudi Arabia?
- What are the obstacles to implementing gamification in teaching science from the teachers' viewpoints in Saudi Arabia?
- Are there statistically significant differences at the level of ($\alpha \leq 0.05$) between the means scores of the responses according to the variables of specialization, academic qualification, years of experience, gamification-based training courses, and the teachers' affiliation?

3. Method

The mixed-method approach was adopted in this study. This approach is defined by Creswell and Creswell (2017) as an approach that includes collecting and integrating quantitative and qualitative data through distinct research designs.

Since the current study aims to identify the degree of using gamification in teaching science and the obstacles from the teachers' point of view in Saudi Arabia, the mixed, convergent, parallel approach is the most appropriate to help achieve the goal of the study. In this design, quantitative and qualitative data are collected simultaneously. Then, the information obtained from that data is incorporated into the interpretation of the study's overall results (2018). The basic premise of this design is that quantitative and qualitative data give different forms of information. However, they must lead to the same result (2018).

3.1. Population and sampling

The study population consists of the science primary school teachers in the Makkah region (n=328), according to the latest statistic at the time of conducting the study at hand. The sample encompassed 200 teachers. Characteristics of the sample are outlined below.

Table 1 shows that 12.0% of the sample hold a diploma, 9.0% have a non-educational bachelor's degree, 75.0% have a Bachelor of Education, and 4.0% are postgraduates.

Table 1: Description of the sample according to qualification

Qualification	Frequencies	%
diploma	24	12.00%
Non-educational bachelor's degree	18	9.00%
Bachelor of Education	150	75.00%
Postgraduate	8	4.00%
Total	200	100.00%

As displayed in Table 2, 9.0% of the sample have less than five-year experience. The experience of 38.0% of them varied from 5 to less than ten years, and 53.0% had ten years plus experience.

Table 3 shows that 67.0% of the study sample majored in elementary sciences, 12.0% in biology, 10.0% in physics, and 11.0% in chemistry.

Table 2: Description of the sample according to years of experience

Years of experience	Frequencies	%
less than 5 years	18	9.00%
5 –10 years	76	38.00%
10+ years	106	53.00%
Total	200	100.00%

Table 3: Description of the sample according to specialization

Specialization	Frequencies	%
Bachelor (Elementary Science)	134	67.00%
Biology	24	12.00%
physics	20	10.00%
chemistry	22	11.00%
Total	200	100.00%

3.2. Instruments

Driven by the nature of the data and the approach adopted, the study used questionnaires and interviews as data collection tools.

3.2.1. Questionnaire

It consists of two parts. The first part contains the study variables: Years of experience, qualification, specialization, training courses related to gamification, and the Education Office to which each teacher is affiliated. The second part consists of three axes. The first is the axis of importance. It consists of eleven items. The axis of use consists of nine items. The axis of obstacles is divided into two parts-administrative barriers (seven items) and the barriers related to the teachers (nine items).

Validity and reliability of the questionnaire

Internal consistency: After confirming the apparent validity of the tool, the researcher applied it to a survey sample consisting of 31 teachers to calculate the validity of its internal consistency. Through the response of the exploratory sample, the validity of the internal consistency of the questionnaire was calculated as such:

1. Pearson's correlation coefficient between the degree of each item and the total score of the axis to which the item belongs. Tables 1 to 3 show the results.
2. Pearson's correlation coefficient between the score of each axis and the total score of the questionnaire.

Table 4 shows that the Pearson correlation coefficient between all items and the total score for the importance of the axis of using gamification in teaching science is statistically significant at ά less than 0.01, which indicates its reliability to be used in the present study.

Table 5 indicates that Pearson's correlation coefficient between all items and the total score for using gamification in teaching science is statistically significant at a significance level less than 0.01, indicating it's for the present study.

Table 4: Pearson correlation coefficient between each item's score and the total score of the importance of gamification in teaching science

No.	Items	Correlation Coeff.
1	The interaction of scientific students during the lesson increases when using gamification.	.815**
2	Gamification makes learning science exciting and fun.	.875**
3	Gamification contributes to students' trial and error without fear of negative consequences.	.912**
4	gamification promotes honest competition among students.	.871**
5	Given the contemporary changes, using gamification in teaching science is necessary.	.887**
6	Gamification promotes individual differences among students.	.863**
7	It is easier for students to understand science topics when using gamification.	.951**
8	gamification promotes students' motivation during learning.	.914**
9	Gamification helps to achieve the objectives of the lesson.	.872**
10	Using gamification facilitates students' understanding of scientific concepts.	.840**
11	Gamification encourages students to perform enriched activities at home.	.885**
12	Using gamification is a waste of time.	.509**

**Statistically significant at a significance level less than 0.01

Table 5: Pearson correlation coefficient between each item's score and total score of using gamification in teaching science

No.	Items	Correlation Coef.
13	I use gamification-based Apps to simplify learning science.	.881**
14	I used gamification to warm up and help students be ready for the science lessons.	.910**
15	I use gamification-based Apps to change the class routine and have the stamina.	.946**
16	I use gamification to increase honest competition among students.	.957**
17	I give students gamification-enriched activities to do at home.	.826**
18	I use gamification to consider the individual differences among students.	.891**
19	I use gamification to get student's attention to the lesson.	.915**
20	I give students gamification-based remedial activities to do at home.	.900**
21	I use gamification as a new method of teaching science.	.942**

** Statistically significant at a significance level less than 0.01

Table 6 shows that Pearson's correlation coefficient between all items and the total score for the axis of obstacles to using gamification in teaching science is statistically significant at a significance level of less than 0.01. This indicates its applicability to the study sample.

Table 6: Pearson correlation coefficient between each item's score and total score of obstacles to gamification in teaching science

No.	Items	Correlation Coef.
22	My school administration is not interested in applications and training courses on gamification.	.645**
23	My school administration does not provide rewards to or encourage teachers who use gamification.	.787**
24	The teaching and administrative burden limit my use of gamification.	.685**
25	Dearth of training courses on integrating technology into teaching.	.692**
26	The large number of students in one class hinders gamification.	.633**
27	Poor infrastructure and modern educational tools and devices provided by the school admin do not meet desired outcomes.	.643**
28	My school does not have a Wi-Fi network for educational purposes.	.603**
29	The sizeable scientific content of the science subject reduces my use of gamification.	.707**
30	I do not have the technical skills to use gamification.	.646**
31	I have difficulties figuring out which Apps and software support gamification.	.720**
32	The lack of laptops or iPads for some students reduces my gamification use.	.577**
33	gamification does not serve the educational process in some lessons of the science subject.	.728**
34	I find it hard to use gamification.	.759**
35	My lack of knowledge of gamification in teaching science limits my use.	.686**
36	I think gamification is a waste of time.	.588**
37	I feel that gamification counts as a new burden to the teacher.	.562**

**Statistically significant at a significance level less than 0.01

Table 7 clearly shows that Pearson's correlation coefficient between all axes and the total degree of the questionnaire is statistically significant at a significance level of less than 0.01, which indicates the cohesion of these axes and their validity for use in the present study.

Table 7: Pearson correlation coefficient between each axis' score and the total score of the questionnaire

No.	Part	Correlation Coef.
1	The importance of gamification in teaching science.	.950**
2	The use of gamification in teaching science	.870**
3	Obstacles to gamification in teaching science	.514**

**Statistically significant at a significance level less than 0.01

Reliability

Cronbach's alpha formula verified the stability of the resolution, and Table 8 shows the relevant results.

As Table 8 indicates, Cronbach's alpha values of all the axes in the questionnaire and the questionnaire as a whole are statistically acceptable (Creswell and Creswell, 2017). The reliability coefficient is considered statistically acceptable if its value is higher than 0.60. It indicates that the validity of the questionnaire is adequate to be used in the study.

Table 8: Cronbach's alpha coefficient of the questionnaire

No.	Axis	N	Alpha Cronbach
1	The importance of gamification in teaching science.	12	0.963
2	The use of gamification in teaching science.	9	0.973
3	Obstacles to gamification in teaching science.	16	0.913
4	The survey as a whole	37	0.956

3.2.2. Interview

The interview is the second tool of the study. Al-Azzawi (2008) mentioned that the interview is "one of the important tools that researchers use in collecting information and data that cannot be obtained using other tools." In an interview, the researcher can adapt the situation to obtain sufficient accurate and precise information because he is in direct contact with the person who is the source of information. The researcher conducted interviews with six science teachers, asking them the same questions of the study. The interviews were recorded, transcribed, and coded (for analysis) based on their opinions.

Validity and reliability of the interview

The researcher designed a semi-structured interview that contains some questions that may give clarification, support, and interpretation of the questionnaire results.

The supervisor accepted some of the arbitrators in the specialization, and some questions were modified based on their opinions As Creswell and Creswell (2017) indicated, one of the methods of verifying the validity of the tool in qualitative research is peer debriefing. The supervisor presented the interview questions to some arbitrators in the specialization. Some questions were modified based on their opinions.

4. Results and discussion

4.1. Research question #1

What is the importance of gamification in teaching science from the teachers' viewpoints in Saudi Arabia?

The means, standard deviation, ranks, and degree of Significance were applied to the participants' responses to answer the first research question. This encompassed responses to Axis 1 of the research

tool: The importance of using gamification in teaching science from the point of teachers in Makkah (see Table 9).

Table 9: Descriptive statistics (means, St. D, and rank) of the importance of gamification in teaching science from teachers' viewpoints

No.	Gamification is important from the science teachers' point of view in the following:	Means	St. D.	Rank	Sig.
1	The interaction of scientific students during the lesson increases when using gamification.	4.13	0.802	2	high
2	Gamification makes learning science exciting and fun.	4.16	0.803	1	high
3	Gamification contributes to students' trial and error without fear of negative consequences.	3.87	0.866	9	high
4	gamification promotes honest competition among students.	4.03	0.805	5	high
5	Given the contemporary changes, using gamification in teaching science is necessary.	3.84	0.96	10	high
6	Gamification promotes individual differences among students.	3.77	0.928	11	high
7	It is easier for students to understand science topics when using gamification.	4.01	0.859	**6**	high
8	gamification promotes students' motivation during learning.	4.12	0.774	3	high
9	Gamification helps to achieve the objectives of the lesson.	3.88	0.86	8	high
10	Using gamification facilitates students' understanding of scientific concepts.	4.08	0.77	4	high
11	Gamification encourages students to perform enriched activities at home.	3.94	0.812	7	high
	Axis as a whole	3.98	0.696		high

Table 9 shows that the degree of importance of the application was high. The mean value is 3.40 to less than 4.20. The axis as a whole, related to the importance of gamification in teaching science from the point of view of teachers, had a high degree of importance (mean=3.98; St. D=0.696). This result indicates high importance.

Item 2: gamification makes learning science fun and exciting. this item has the highest mean among the axis items (μ=4.16; St.D=0.803). The mean comes within the category (3.40 to less than 4.20). Thus, it came in the highest category and ranked first.

Item 1: The interaction of science students during the lesson increases when gamification is used. Among the items on the axis, this item has the second highest mean value (μ=4.13; St.=0.802). The mean score comes within the category of 3.40 to less than 4.20. Thus, it came in the second highest category and ranked second. This indicates a high degree of agreement among the sample on gamification as it promotes fun and excitement in teaching science and increases the interaction among science students during the lesson. This may be due to the features of gamification that facilitate scientific concepts and break the routine in the lesson. It is also possible that it helps to overcome what may accompany traditional learning, such as feeling bored or absent as well as mental wandering during the lesson. It makes the educational environment becomes exciting and enjoyable and full of interaction, challenges, and competition between students on the one hand, and between the students and teachers on the other hand.

Six teachers were interviewed to confirm the questionnaire results, explicitly answering the same question–What is the degree of gamification's importance in teaching science? Their answer indicated their agreement and awareness of the importance of gamification. Teacher No. 2 emphasized its importance, saying, "It is vital because today's student is not a traditional student like before, but rather a discoverer and information seeker; it is a means that attracts the student's attention in the first place during the lesson." Teacher No. 3 added, "gamification is interesting in that it provokes enthusiasm and suspense in the lesson," a view endorsed by Teacher No. 1 and Teacher No. 4. As for Teacher No. 5 pointed to its importance by saying: "it breaks the routine in the class, diversifying how lessons are presented and introducing joy." happiness in the hearts of the students.

Thus, their opinions align with the conclusion reached through the questionnaire on the axis of importance, which came to a high degree this indicates teachers' awareness. The axis, as a whole, came with a high degree of importance as a result of a high degree of awareness among science teachers in the city of Makkah towards the importance of using gamification in teaching science. In the current era, the teacher has become more developed and open to other societies and developed countries and desires to learn everything new, familiar with technical developments and rapid changes. This has led to their awareness and acceptance of everything that is new and serves the educational process until they become more able to keep pace with the new generation—keeping up with and attracting them, especially as they are interested and attracted to technology and everything related to it (Chevtchenko, 2013; Burkey et al., 2013; Armier et al., 2016).

4.2. Research question #2

What is the extent to which they believe gamification is implemented in Saudi Arabia?

The means, standard deviation, ranks, and degree of significance were obtained (see Table 10).

As data in Table 10 shows, the degree of using gamification was moderate according to science teachers (μ=3.26; St=0.925). Item 18, which is relevant to using gamification to attract the student's attention to the lesson, has the highest mean score among all the items on the axis (μ=3.59; St=1.090). This indicates a high agreement among the sample on gamification to attract student's attention to the scientific material. Moreover, their attitudes toward this strategy, as confirmed by Ibanez et al. (2014), and Burkey et al. (2013). The reasons are that gamification makes learning different from the traditional pattern. It includes active routine,

competition, and challenge–factors that increase the students' enthusiasm, participation, and attitudes towards the subject, as confirmed by Ibanez et al. (2014) and Burkey et al. (2013).

Table 10: Descriptive statistics (means, St. D, and rank) of using gamification in teaching science from teachers' viewpoints

No.	Items	Means	St. D	Rank	Deg.
12	I use gamification to simplify science learning.	3.26	1.053	5	Moderate
13	I used gamification to warm up and help students be ready for the science lessons.	3.21	1.015	7	Moderate
14	I use gamification-based Apps to change the class routine and have the stamina.	3.49	1.075	2	High
15	I use gamification to increase honest competition among students.	3.48	1.089	3	High
16	I give students gamification-enriched activities to do at home.	2.93	1.152	8	Moderate
17	I use gamification to consider the individual differences among students.	3.25	1.184	6	Moderate
18	I use gamification to get student's attention to the lesson.	3.59	1.090	1	High
19	I give students gamification-based remedial activities to do at home.	2.83	1.152	9	Moderate
20	I use gamification as a new method of teaching science.	3.29	1.073	4	Moderate
	Axis as a whole	3.26	0.925		Moderate

Items 16 and 19 in Table 10, however, had the least mean scores among the axis items. The means scores of these two items were 2.93 and 2.83 respectively with a standard deviation value of 1.152 for both. This indicates a medium degree of agreement among the sample on giving the students gamification-based homework and remedial activities.

The activities benefit the students and improve their levels. Enrichment activities, for example, enrich the students' information about the lesson. When they are used to applying the characteristics of gamification through an application, this will encourage the students to achieve and thus have a positive impact on increasing academic achievement and increasing the motivation to learn (Burkey et al., 2013). The reason for this may be the lack of interest of some teachers in activating enrichment and therapeutic activities through a program based on gamification. It is to be pointed out that these activities benefit the students and improve their levels, such as enrichment activities, which enrich the lesson. When used in conjunction with the characteristics of gamification through an application, this juxtaposition promotes students' achievements and thus increases students' academic achievement and motivation them to learn (Dichev and Dicheva, 2017).

In terms of remedial activities, they are given to the students whose level is below their peers' level and below the required level. Such activities improve their level. When combined with gamification, it will help them solve problems. Additionally, gamification is suitable for students, particularly at this stage of education. The reason why items 16 and 19 had the least value is the low technical competencies of some science teachers and their lack of knowledge of integrating enrichment and gamification-based remedial activities. Responses to the survey under the axis of teacher-related obstacles confirm this result. for instance, Item 29 reads, "I do not have the technical skills to use gamification" and had a mean score of 3.04 and a standard deviation of 1.179. This indicates that several science teachers do not have the necessary technical skills, and they need a program to qualify them to integrate technology into their teaching and identify modern strategies, including gamification.

Six teachers were interviewed to confirm the questionnaire results, explicitly answering the same question–What does the degree of your gamification use in teaching science? Their answer indicated that teachers resort to using gamification in some classes. For instance, Teacher No. 2 confirmed that she used gamification but not in all her classes. Likewise, Teacher No. 1 agrees with Teacher 2, depending on the time available for embedding gamification in classes. Moreover, Teacher No. 5 asserted that she sometimes uses this technique in her teaching because she does not have all she needs for using it; Teacher No. 4 holds the same view. It has been evident that some teachers use the technique without their knowledge that it is called gamification; they use some applications characterized by the elements of gamification, including competition, challenge, and collecting points. Teacher No. 3 mentioned that she sometimes uses interesting iPad programs for the students. After explaining the idea of the App, it became apparent that it does what gamification does. In conclusion, some teachers used this technique without their knowledge.

Hence, the interviewees' responses align with the results ensued from the questionnaire regarding the axis of gamification use. It had an average mean score, showing that teachers sometimes use it in their teaching. This result could be attributed to the lack of a clear and complete picture of gamification or the misunderstanding of some teachers. It may also stem from their belief that simple games stand for gamification in their integrated form and misunderstand its correct meaning. They may also confuse educational games and gamification. It depends on the game elements and their activation through special programs and applications. The characteristics of games such as challenge, competition, points, and medals are activated.

4.3. Research question #3

What are the obstacles to implementing gamification in teaching science from the teachers' viewpoints in Saudi Arabia?

The means, standard deviation, ranks, and degree of significance were obtained (see Table 11).

4.3.1. Administration-related obstacles

Data outlined in Table 11 shows the administration-related obstacles to using gamification in teaching science from the viewpoint of science teachers. It evinces that the whole part of administration-based obstacles had a high degree. The means values fall within (3.40 to less than 4.20. Evidently, the most prominent of these obstacles is Item 27, which relates to the Wi-Fi network used for educational purposes. This item had the highest mean value (4.33) with a standard deviation (0.832), a mean value of 3.71, and a standard deviation of 0.711. This indicates a very high agreement among the sample that lack of Internet connection constitutes an obstacle to them and that science teachers suffer from the lack of a good Internet connection in the present study setting. It goes without saying that modern strategies (including gamification) are mainly internet-based. The result confirmed prior claims that internet interruption in the school is one of the obstacles to using gamification among computer teachers related to school administration and financial capabilities.

Table 11: Descriptive statistics (means, St. D, and rank) of administration-related obstacles to gamification in teaching science from teachers' viewpoints

No.	Items	Means	St. D	Rank	Deg.
21	My school administration is not interested in applications and training courses on gamification	3.09	1.071	7	Moderate
22	My school administration does not provide rewards to or encourage teachers who use gamification.	3.26	1.066	6	Moderate
23	The teaching and administrative burden limit my use of gamification.	3.76	1.014	4	High
24	Dearth of training courses on integrating technology into teaching.	3.41	1.09	5	High
25	The large number of students in one class hinders gamification.	4.14	1.006	2	High
26	Poor infrastructure and modern educational tools and devices provided by the school admin do not meet desired outcomes.	4.02	1.02	3	High
27	The school does not have a Wi-Fi network for educational purposes.	4.33	0.832	1	Very high
	Administration-related obstacles as a whole	3.71	0.711		High

Nevertheless, Items 21 and 22 in Table 11 had the least mean values among all the axis items. The mean values for the two terms were 3.09 and 3.26, with a standard deviation for the two terms, respectively 1.071 and 1.066 This indicates a moderate degree of agreement among the study sample that the school administration is interested in providing training courses and is interested in providing incentives and rewards to encourage teachers. The reason for the varying responses may be that some school leaders are interested in providing refresher courses on modern teaching strategies for teachers, enrolling them in training programs, or completing their studies by giving them permission to do so, and leveling the obstacles they encounter. With these in mind, they are supportive, cooperative, and encouraging, unlike some school administrations that are not interested in supporting their teachers and do not work to overcome the obstacles they face.

Six teachers were interviewed to confirm the questionnaire results, explicitly answering the same question–What do the administrative-based hurdles of gamification use in your science teaching? Their answer indicated some major obstacles. Teacher No. 1 stated that "the lack of a private internet network in the school" for female teachers and students hinders the activation of modern strategies that require a good internet connection. The other five teachers who were interviewed agreed on this obstacle. Add to that a scarcity of devices for both teachers and students. Teacher No. 3 declared, "Our school does not provide the equipment we need, and there is no private resource room." Teachers 2, and 5 agreed on this obstacle. This means that the failure to provide a room in some schools, such as the resource room with devices for students and a projector equipped with everything the teacher and students need, is an obstacle for some teachers.

Besides the abovementioned obstacles, assigning some administrative tasks and extracurricular activities to teachers increases their job tasks. This overload obstructs applying modern strategies, including gamification. This was mentioned by Teachers 6, 5, and 1. Assigning the administration to some teachers with extracurricular activities is outside the curriculum framework and classes provided to students, either to educate them or activate some events. Every week, there is often a new activity, as most of these activities are performed during regular classes. Therefore, they constitute an additional burden on teachers and hinder them from teaching their specialized subjects. Teachers No. 4, 5, and 1 agreed on the small class size, which constitutes an obstacle.

This confirms the results obtained from the questionnaire that the administrative obstacles to gamification in teaching science had a high degree, which indicates that the sample suffers from a lack of an educational environment, infrastructure, and motivating and assisting capabilities in schools in the context of the study. The large classes, teaching burden, and the lack of school administration's interest in providing training courses for teachers pertaining to gamification were striking obstacles.

4.3.2. Teacher-related obstacles

Table 12 indicates that the teacher-related obstacles to using gamification in teaching science were found at a moderate degree with mean scores of 3.27 and 0.747a standard deviation. Among the axis items, Item 31, which states that the lack of

laptops or iPads for some students reduces my use of gamification, received the highest mean value (μ=4.10; St.D=1.015). It ranked the highest among all the teacher-related obstacles. This indicates a high level of agreement among the sample that the lack of mobile devices and iPads for some students reduces their use of gamification. This may result from the fact that government-run schools are homes of a lot of students from all social classes; not all of them belong to rich families to afford such devices for their daughters and sons, some of them are not financially able, and it is difficult for them to provide devices because of their poor financial conditions. Others believe that acquiring electronic devices is not suitable for children at an early age. Some school administrations do not allow students to bring their devices, thus causing it. This is a salient obstacle for the teacher because using gamification requires the students to have special devices to respond to their teacher. Some are not financially able and find it challenging to provide equipment because of their poor financial conditions. Others believe that the acquisition of electronic devices is not suitable for children at an early age. Besides, some school administrations do not allow students to bring their devices. Therefore, this causes a major obstacle for the teacher because using gamification requires the presence of special devices for the students to respond to their teachers.

Table 12: Descriptive statistics (means, St. D, and rank) of teacher-related obstacles to gamification in teaching science from teachers' viewpoints

No.	Items	Means	St. D	Rank	Deg.
28	The sizeable scientific content of the science subject reduces my use of gamification.	4.06	0.996	2	high
29	I do not have the technical skills to use gamification.	3.04	1.179	6	Moderate
30	I have difficulties figuring out which Apps and software support gamification.	3.18	1.133	4	Moderate
31	The lack of laptops or iPads for some students reduces my gamification use.	4.1	1.015	1	high
32	gamification does not serve the educational process in some lessons of the science subject.	3.34	1.068	3	Moderate
33	I find it hard to use gamification.	3.13	1.043	5	Moderate
34	My lack of knowledge of gamification in teaching science limits my use.	2.97	1.058	8	Moderate
35	I think gamification is a waste of time.	2.59	1.127	9	low
36	I feel that gamification counts as a new burden to the teacher.	3.04	1.239	7	Moderate
	Teacher-related obstacles as a whole	3.27	0.747		Moderate

Item 28, which states that the sizeable scientific content of the science course reduces my use of gamification received a high mean value (μ=4.06; St.D=0.996). It ranked second among the teacher-related obstacles. This indicates that there is great agreement among the sample members that the magnitude of the scientific content limits using gamification.

Item 35 (I think using gamification is a waste of time) got the lowest mean value (μ=2.59; St.D=1.127). The value indicates that most of the teachers had no negative attitudes towards gamification. They believe it is an important strategy as confirmed by their response to this questionnaire in the axis. The axis as a whole, specifically the degree of importance of the gamification method in teaching science from the point of view of female teachers in Makkah, received a high degree of importance.

Six teachers were interviewed to confirm the questionnaire results, explicitly answering the same question–What are the obstacles associated with the female teacher that hinder science teachers from applying the gamification method from your point of view?Teacher No. 4 asserted that "the length of the science curriculum and the sizeable contents, including rules, experiments, and terminologies represent an obstacle for teachers in using up-to-date strategies. This view is supported by teacher No. 1, who confirmed that the science classes are few and have a heavy curriculum. That is to say, few classes with the intensity of the curriculum are an obstacle for them.

Obstacles also included those teacher-student-related obstacles. Teacher No. 2 contends that because most of the students did not own iPads and lack of experience in dealing with technology hinders them from activating the modern strategies based on technology. This was agreed upon by Teacher No. 3 and Teacher No. 6.

As for teacher-related obstacles, Teacher No. 3, when she was asked why the teachers have no previous background about gamification despite being a modern method, affirmed that teachers did not get to learn it before, neither through attending training courses nor practical lessons related to this method. Consequently, they did not know its existence or importance, which led to its non-application. This was confirmed by Teacher No. 2 and Teacher No. 5.

From another angle, Teacher No. 2 postulated that one of the reasons could be that some teachers are not convinced about communicating information via gamification, as they consider it only a means of entertainment and a waste of time. This reason may constitute a major obstacle. Some teachers' negative attitudes towards integrating technology into teaching, adopting modern strategies that suit students in this era, and conviction of its importance in education affect using it.

One more reason related to teachers includes teachers' lack of using technology, a view supported by what Teacher No. 3 asserted. She mentioned that

"the teacher's lack of experience in dealing with technology" may be a reason because the teacher's lack of experience in using devices that need technical knowledge is an obstacle, a view supported by Teacher No. 6.

Teacher No. 3 added that teacher boredom and unwillingness to develop could account for abstaining from gamification. This respondent assumed that boredom with teaching and unwillingness to catch up with the new in education leads to a lack of intrinsic motivation and, thus, not using anything new in education, including gamification.

Some of the respondents' responses ensued from the interview align with the results of the questionnaire and this alignment confirms the existence of obstacles.

With the discussion above in mind, it is concluded that science teachers at the primary stage face severe difficulties in using gamification. where the arithmetic mean of administrative obstacles was 3.71. The mean score for administrative obstacles was 3.71 while the mean value of the teacher-related obstacle was 3.27 (see Table 13).

Table 13: Descriptive statistics (means and St. D) of obstacles to gamification in teaching science from teachers' viewpoints

No.	Dimension	Means	St.D	Degree
1	Administrative Obstacles	3.71	0.711	High
2	Teacher-related Obstacles	3.27	0.747	Moderate
3	Obstacles as a whole	3.49	0.642	High

These results indicate that the schools of Makkah still need further development that aims to improve the classroom environment and develop the teachers' skills. It is impossible to advance the educational process with these striking obstacles.

4.4. The results of the 4th question, discussion, and interpretation; question #4

Are there statistically significant differences at the level of α≤0.05 between the means scores of the responses according to the variables of specialization, academic qualification, years of experience, gamification-based training courses, and the teachers' affiliation?

To answer this question, non-parametric statistical analysis was used. The question was divided into three parts to facilitate tracking the answer.

4.4.1. Years of experience-related differences

The results outlined in Table 14 show that there are no statistically significant differences at the level of significance (α≤0.05) between the responses of the study sample members to the three axes of the questionnaire according to the variable "number of years of experience." The significance level for all axes is greater than 0.05. This could be attributed to the lack of differences according to the variable number of years of experience to the similarity of the conditions of the teachers. Most science teachers have long experience. The majority of them have more than ten years of experience in teaching. This indicates that they have similar technical skills unless there are passionate teachers; unless there are passionate teachers who may make the difference in activating modern technology-based strategies, including gamification. It can be said that there are no differences between the axis of the questionnaire according to the difference in the number of years of their work. This result confirmed the absence of statistically significant differences attributable to years of experience.

4.4.2. Qualification-related differences

Table 15 indicates that there are no statistically significant differences at the level of significance (α≤0.05) between the responses of the study sample members towards the three questionnaire axes according to the variable "Educational Qualification," as the significance level for all axes is greater than 0.05. This result may be because the teacher's obtaining a higher academic qualification that increases her job duties or her promotion.

Table 14: Results of the Kruskal Wallis test based on the three axes of the questionnaire according to years of experience

Domain/ axis	Chi-Square	Experience	Rank means	N	Chi-Square	Sig.
importance of gamification in teaching science.	3.192	Below 5 years	88.36	18	3.192	0.203
		5 –10 years	94.04	76		
		10+ years	107.19	106		
Extent of using gamification in teaching science	1.797	Below 5 years	101.81	18	1.797	0.407
		5 –10 years	93.61	76		
		10+ years	105.22	106		
administrative obstacles to gamification in teaching science	2.379	Below 5 years	92.83	18	2.379	0.304
		5 –10 years	108.46	76		
		10+ years	96.09	106		
teacher-related obstacles to using gamification in teaching science	1.103	Below 5 years	111.67	18	1.103	0.576
		5 –10 years	102.45	76		
		10+ years	97.21	106		
The obstacles as a whole	1.021	Below 5 years	101.11	18	1.021	0.6
		5 –10 years	105.55	76		
		10+ years	96.77	106		

Therefore, this qualification is not directly utilized in the education process. This may be due to the existence of a gap between what is being studied to obtain the academic qualification and the applied reality in the field. Therefore, the educational qualification variable significantly affects making any statistical differences. This result confirmed no statistically significant differences attributable to years of experience.

Table 15: Results of Kruskal Wallis test based on the three axes of the questionnaire according to the variable of qualifications

Domain/ axis	Qualification	N	Rank means	Chi-Square	Sig.
Importance of gamification in teaching science.	diploma	24	85.17	2.088	0.554
	Non-educational bachelor's degree	18	98.33		
	Bachelor of Education	150	103.29		
	Higher studies	8	99		
Extent of using gamification in teaching science	diploma	24	89.71	1.071	0.784
	Non-educational bachelor's degree	18	99.75		
	Bachelor of Education	150	101.9		
	Higher studies	8	108.25		
Administrative obstacles to gamification in science education.	diploma	24	104.44	1.041	0.791
	Non-educational bachelor's degree	18	97.47		
	Bachelor of Education	150	99.25		
	Higher studies	8	118.88		
Teacher-related obstacles to using gamification in teaching science.	diploma	24	102.98	1.796	0.616
	Non-educational bachelor's degree	18	100.75		
	Bachelor of Education	150	101.5		
	Higher studies	8	73.81		
The obstacles as a whole	diploma	24	105.81	0.359	0.949
	Non-educational bachelor's degree	18	98.83		
	Bachelor of Education	150	100.26		
	Higher studies	8	92.88		

4.4.3. Specialization-related differences

Table 16 exhibits that there are no statistically significant differences at α≤0.05 between the responses of the study sample members towards the three questionnaire axes according to the variable "specialization," as the significance level for all axes is greater than 0.05. This result indicates the convergence of the responses of the study sample members despite their different specializations. This is because all teachers of different specializations study the same subject, the same curriculum, and the same number of lessons, and they have the same problems and difficulties that may be an obstacle to the application of modern teaching methods, including the method of gamification. Therefore, the specialization variable did not have an effect on causing any statistical differences.

Table 16: Results of Kruskal Wallis test based on the three axes of the questionnaire according to the variable of specialization

Domain/ axis	Specialization	N	Rank means	Chi-Square	Sig.
Importance of gamification	Science (Elementary)	134	101.16	6.154	0.104
	Biology	24	119.92		
	physics	20	97.45		
	chemistry	22	78.05		
Degree of using gamification	Science (Elementary)	134	100.32	1.444	0.695
	Biology	24	102		
	physics	20	111.38		
	chemistry	22	90.05		
Administrative-Related Obstacles	Science (Elementary)	134	101.65	0.359	0.948
	Biology	24	99.33		
	physics	20	93.5		
	chemistry	22	101.14		
Teacher-related obstacles	Science (Elementary)	134	101.43	0.504	0.918
	Biology	24	94.02		
	physics	20	104.98		
	chemistry	22	97.82		
Obstacles as a whole	Science (Elementary)	134	101.67	0.199	0.978
	Biology	24	96.44		
	physics	20	98.75		
	chemistry	22	99.41		

Touched on the above, it is clear that all the results of the fourth research question showed no differences between the responses of the study sample members towards the three questionnaire axes due to the variables of specialization, educational qualification, and the number of years of experience.

5. Recommendations

Based on the results, the researcher recommends the following:

- The preparation and training programs for pre-service teachers or in-service teachers should focus on developing the teachers' skills related to the use of modern teaching methods, including gamification, and qualify them to apply such methods while teaching the science course.
- Using gamification in teaching the science course is recommended; this method allows a transition to an interesting, fun, and interactive learning environment.
- Organizing training courses and workshops and establishing a training program for science teachers to train them on how to employ gamification in teaching science courses and integrate technology into their teaching.
- School supervisors should encourage science teachers to use modern teaching methods, including gamification in science, to promote students' motivation, passion, and enthusiasm for learning.
- Paying attention to the infrastructure in public education schools and providing them with the necessary techniques and means of communication to facilitate teachers' use of strategies and modern technology-based methods such as gamification.

Providing the necessary support for school administrators to incentivize science teachers to use strategies and modern methods in the educational process, including gamification-based teaching. This motivates and encourages them to continue being creative and applying everything new that serves the educational process like other teachers.

Compliance with ethical standards

Conflict of interest

The author(s) declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

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