ORIGINAL ARTICLE

Gamification in Cardiovascular Pharmacology Course as Real Work Simulation by Case on Medical Sciences

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ABSTRACT

Background: Nowadays, with improvement of science and technology, most organizations and educational institutions are interested to use e-learning for teaching their learners.

Aim: In this study we developed and evaluated gamification in cardiovascular pharmacology lessons for the nursing students of Jahrom University of Medical Sciences.

Methods: This study was guise experiment study conducted in two parts (design, implementation, and evaluation). The first part was writing the scenario of the game, the questions byexpert panel, and agreement-based. In the next level, gamification was designed by the Microsoft Asp.net Core technology withspecialized team of educational and engineering designers. Then, it was delivered on www.pharmaplay.ir.

Results: Intervention was conducted on 30 students from nursing and paramedical students. Data collection was performed using a questionnaire with 21 questions, 5 continuum with 4 dimension and professors' attitudes were examined by 23 questions from advantages and disadvantages of the app.Also, the students' learning was assessed with pre-test and post-test. The analysis showed that qualitative mean was related to profound learning and enjoyment. In general, the participants had positive opinions in all fields (higher mean all items). In evaluation of professors' viewpoints, in general, the qualitative mean of views was 3.43 that is an indicator of their positive viewpoint on this educational method. Students' scores of learning increased from the mean (14.70vs 17.6) after playing the game.

Conclusion: Using new and active methods by engaging the students in their learning and creating an attractive and fun environment can help students to learn more effectively and profoundly, and also allow them to enjoy learning in a motivational environment.

Keywords: Pharmacology course, Gamification, Motivation, Medical education, Active learning

INTRODUCTION

While internet and PCs, also portable ones, are getting new capabilities and emerge every day; on the other hand,the development of programming languages and different software facilitate presenting educational contents have made major changes in educational systems. It seems that, the use of these facilities for training has led to the promotion of education quality and help inclusive orientation, active and lifelong learning, interaction in learning, and multimedia education; therefore, it leadsthe human being to a major educational revolution[1]. Computer-assisted learning is considered to be any kind of educational activity that uses the computer as a primary means of teaching content[2]. Medical education based on the use of simulators SBME (Simulation-Based Medical Education), is any kind of educational activity that uses a simulation of clinical scenarios to increase the students' knowledge and skills[3]. Lack of manpower and development of nursing, as a special profession, increased the need for trained nurses in the context of patient's care with complex and different clinical conditions. On the other hand, since there is a dynamic environment in hospital wards; the need to use up-to-date, reliable, and accessible resources is essential in providing nursing education and necessitates continuous training programs for clinical nurses [3]. Since the clinical workload and the structure of care provided in hospital wards preclude the free presence for nursing groups in traditional education classes,but the effectiveness of conventional teaching methods still need to be assessed.Gamification is defined as 'the use of game design elements in non-game contexts'. Accordingly, Gamification-based was well-accepted among new generation as the millennial learners. This method can be used to develop some strategies to augment learning in time- limited condition andcan be considered as a motivator of participant in learning[4].

A systematic literature review has shown that, gamification has positive effectson many fields such as increasing the motivation, engagement in learning, as well as enjoyment from learning[5].

Gamification has motivational affordances fromgames to invoke behavioral outcomes, which also increase engagement[6]. One of the issues that is very important for medical students to learn, and needs urgent attention, is pharmacological knowledge.In this regard, Pharmacology is very important in the provision of nursing care and an important part of nurses' clinical practice on this basis. Also, Medical teams need pharmacological skills to evaluate patients before taking medication,planning the goals of care, safe and effective drug administration, monitoring and evaluation of side effects, teaching the patient and his/her family about when and how to take medication, the reason for prescription, expectations form the drug, react to problems, help the families in care supporting, more effective cooperation with other staffs to

eliminate possible risks, and setting up discharge plans. Therefore, learning this lesson is of particular importance. In this study, we attempted to examine and discuss the effect of cardiovascular drugs in pharmacology courses by executing games on learning and their motivation.

Educational activity and setting: The method of this study was designed in two qualitative and quantitative phases (mixed in design andevaluation). Accordingly, the first level (qualitative) included the content validity of questions consisted of a group of experts (nurses and pharmacologists, medical educators, and e-learning), which was confirmed. In examining the content validity,we tried to cover all the parts by questions, and the number of questions was arranged based on the significance of the medication category and the important care points. Furthermore, to confirm the reliability, we tried to use the questions of the previous exams, and to have the standard formof questioners' design.

In game design, the educational design was used to take into account multiple-choice questions, blank questions, matching, and hot spots. Three scenarios of dynamics, mechanisms, and elements of gamification were also considered in writing the scenarios. In the dynamic section, the items such as cross-section communication skills, promotion to other levels, and narratives of emotional situations and constraints were considered. Moreover, in the mechanism section, the challenges, opportunities, competitions, collaborations, feedback, access to resources, rewards, segmentation, frequent rotations, and rewarding situations were used.

Key elements in the game such as using avatars, models, sets, battles, increasing degrees of freedom, receiving gifts, leaderboards, obstacles, group comparison tables, team status, and virtual goods were used. The combination of these three sections in the form of gamification can create a fun and impressive environment for the students to learn. The software was designed based on the web, and was evaluated on a pilot group of students prior to implementation, and then developed on Android software. Questionnaires were used to investigate the motivational dimensions of the game on the students. The questionnaire has 23 items in 5 domains used by Rahman et al. (2018),whichwas then validated, endured, and used by Mosallanejad and Abdollahifard in a Iranian sample[7,8]. Domains of this questionnaire are motivation, enjoyment, changing behavior, and deep learning.

In order to measure the professor's viewpoints on this method, the valid and endured questionnaire of Mosallanejad et al. with 23 questions was used in two domains of advantages and disadvantages[7,8]. Finally, the paired t-test was used to evaluate the students' learning at two stages of pre and post-test. These questions were drawn from the content of the game, which was determined according to experts, and represented the general knowledge of the student on different cardiovascular drug groups. Data analysis was performed using spss_21 statistical software.

Section one: Designing and implementing game design: Prediction facilities, which were reviewed, and then designed the capabilities of the system implementation, were separated into the following sections. This game is available at http://pharmaplay.ir.

Introducing the game and creating an account: In this section, which is considered as the home page of the web application, the user becomes familiar with the purpose of the game, and can also create an account to start the game.

There are two ways to quickly and easily create an account as follows:

Signing up and logging in with Google Account: In this way, if the user has a Google Email Account, whether it is validated by selecting {Login with Google Account} in the first step, can log into the desktop (dashboard).

Regular registration: In this way, the user should enter the required information including the desired username, email, and password, to create an account and start the game, and will log into the desktop after registration.In both ways, the user is asked to select one of the characters specified in the game for their profile picture after entering the information.If the user has forgotten his/her password, they can click on the forget password link on the homepage and retrieve their password by entering the email by which they created their account. Password information will be sent to the specified email (Fig. 1-6).

Fig 1. The game login page

Desktop: In this section, the user can have access to the following information and features:

- Designed tests ahead.
- View the obtained scores and stars in the levels.
- View medals that were taken from each test.
- Ability to choose the tests ahead.
- Ability to repeat the tests.
- View your rate and compare it with other users.
- Study the guideline for passing the level and become familiar with the questions and answers in each kind of question.
- Ability to resume the tests that have not been completed to the end.

Fig 2.The game dashboard and its levels

Fig 3. The game rules
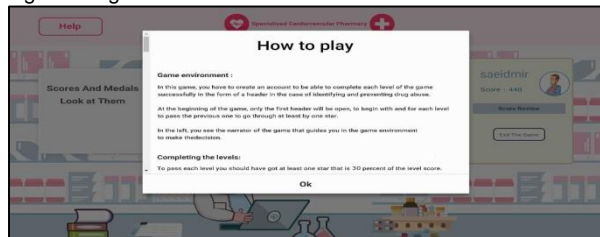
Test in gamification framework

- o Designing the test in gamification framework, according to the predefined requirements and scenarios of each test, and also the questions include the followings:
- ▪ Graphic effects
- ▪ Implementing a variety of designed questions in the test.
- ❖ Single-choice questions (one is correct)
- ❖ Multiple Choice Questions (Multiple choices are correct)
- ❖ Matching Questions (each option matched to a corresponding one)
- ❖ Multiple Matching Questions (Each option can be related to several corresponding ones)
- ▪ Schedule to answer each question.
- o Introducing the purpose and description of each test after selecting and before it begins.
- o Displaying a score after analyzing the user responses.

Fig 4. A sample of single-choice game questions and their answers, with feedback provided on the answer that is right or wrong
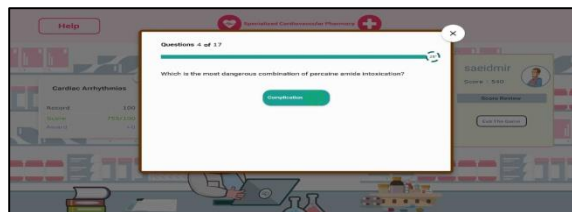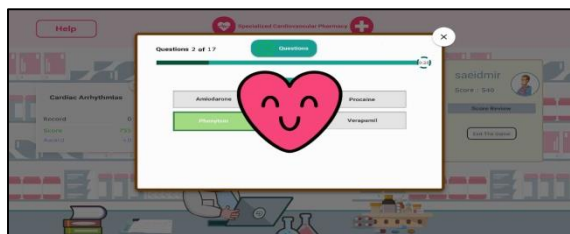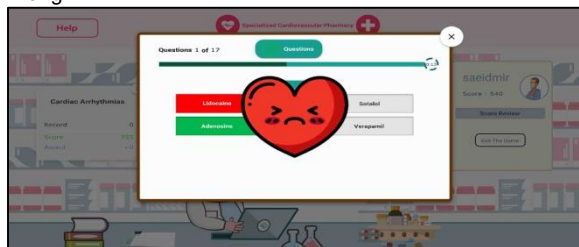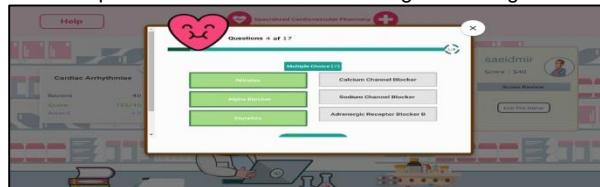

Fig 5. A sample of matching question game and their answers with feedback provided on the answer that is right or wrong.

RESULTS

Thirty students had participated in the study. Their mean age was 20.75 years old(±0.97) and 19(63.3%) of them were females and 11(36.7%) were males.

Evaluation of student motivation and satisfaction: Student questionnaire on motivational dimensions of the game:

As shown in Table 1, the respondents had positive opinionsin all questions from the motivation aspect and the highest qualitative mean was in response to a question about the impact of this type of training on improving the self-management.

As shown in Table 2, the respondents had positive opinions in all questions from the enjoyment aspect, and the highest qualitative mean was in the answers fora question about the impact of this type of training on the increase of positive emotions in the participants.

As shown in Table 3, the respondents had positive opinions in all questions from changing behavior aspect, and the highest quality mean was in response to a question about the effectiveness of this type of training in achieving the goals of the healthcare team.

As shown in Table 4, the respondents had positive opinions in all questions from deep learning aspect, and the highest qualitative mean was in answering a question about the purposeful learning in this way.

From the motivational aspect of all the questions, the respondents had a positive opinion. The highest quality mean was in response to a question about the impact of this type of training on self-management improvement (3.94).

From the enjoyment aspect of all the questions, the respondents had a positive opinion. The highest qualitative mean was in response to a questionabout the impact of this type of training on increasing participants' positive emotion (4.07) (table 5).

From changing the behavior aspect of all the questions, the respondents had a positive opinion. The highest quality mean was in response to a question about the effectiveness of this type of training in achieving the goals of the healthcare team (3.69) (Table 5).

From the deep learning aspect in all questions, the respondents had a positive opinion. The highest qualitative

mean was in answering a question about the purposefulness of learning (4.09) in this way (Table 5).

According to the above table, the highest quality mean was in the domain of deep learning and enjoyment. Generally, the results show the positive opinions of the participants in all domains.

Before and after scores: Results of (Table 6) shows that the students' scores after the intervention had an increasing trend (0.0001). Also, the student scores after playing the game had significantly increased from an average of (14.70 to 17.06).

Faculty evaluation: 10 professors participated in the study. 4 (40%) of them were females and 6 (60%) were males. Their fields were as follows: pharmacology 1 (10%), nursing 2 (20%), education 3 (30%), and other 4 (4%). In the evaluation of the professors, the quality mean was evaluated in each of the questions. Results of the evaluation shows that, since the quality mean of teachers' response was 3.43, the intervention can affect students' learning (Table 7).

Table 1: Students' view on learning by playing cardiovascular pharmacology course in motivation aspect (frequency/percent and mean)

Domain	Question	Very much	Much	Moderate	Low	Very low	Qualitative mean
Motivation	This teaching method is motivational in your learning.	21(26.25)	42(52.5)	16(20)	0 (0)	1(0)	4.025
	It will increase your ability to do professional things.	29(36.26)	25(31.25)	23(28.75)	0(0)	3(3.75)	3.96
	One of the benefits of this teaching method is improvingthe ability of self-management during learning.	29(36.26)	37(46.25)	13(16.25)	1(1.25)	0(0)	4.17
	It can reduce the interest intensity by repeatedly using.	0(0)	14(17. 5)	27(33.75)	27(33. 75)	12(15)	3.47
	This teaching method is associated with positive emotions, due to the increased satisfaction.	21(26.25)	39(48.75)	15(18.75)	5(6.25)	0(0)	3.96
	This teaching method can increase the motivation of learning.	34(42.5)	31(38.75)	9(11.25)	5(6.25)	1(1.25)	4.15
	It can reduce the performance of users.	2(2.5)	2(2.5)	16(23.75)	40(50)	17(21.25)	3.85

Table 2. Students' view on learning by gamification of cardiovascular pharmacology course in enjoyment aspect(frequency/percent and mean)

Domain	Question	Very much	Much	Moderate	Low	Very low	Qualitative mean
Enjoyability	In this teaching method, the activities are fun and learning is enjoyable.	28 (35)	36 (45)	13 (16.25)	2 (2.5)	1 (1.25)	4.1
	In the game, some rewards are unrelated and exaggerated.	4 (5)	3 (3.75)	16 (20)	48 (60)	9 (11.25)	3.68
	Happiness can be achieved through learning in this way.	38 (47.5)	19 (23.75)	17 (21.25)	4 (5)	2 (2.5)	4.08
	Increasing the positive excitement in learning process is one of the benefits of this teaching method.	43 (53.75)	23 (28.75)	11 (13.75)	2 (2.5)	1 (1.25)	4.31
	You enjoy working with virtual patients.	39 (48.75)	21 (26.25)	16 (20)	2 (2.5)	2 (2.5)	4.16

Table 3:Students'(frequency/percent and mean)

Domain	Question	Very much	Much	Moderate	Low	Very low	Mean
Changing behavior	This teaching method facilitates changing behavior and performance.	2(2.5)	45(56.26)	28(35)	5(6.25)	0(0)	3.55
	Gamification is ineffective in achieving the goals of healthcare team.	2(2.5)	4(5)	19(23.75)	36(45)	19(23.75)	3.82

Table 4: Student's opinion on learning by gamification of cardiovascular pharmacology course in deep learning aspect (frequency/percent and mean)

Domain	Question	Very much	Much	Moderate	**Low**	Very low	Mean
	Learning through game can enhance social skills.	3(3.75)	48(60)	18(22.5)	**9(11.25)**	2(2.5)	3.51
	This teaching method increases the satisfaction of learning.	36(45)	27(33.75)	17(21.25)	0(0)	0(0)	4.23
	Learning in this way directly depends on the users' empowerment and characteristics.	11(13.75)	55(68.75)	14(17.5)	0(0)	0(0)	3.96
	Learning in this way directly depends on the users' empowerment and characteristics.	43(53.75)	14(17.5)	21(26.25)	0(0)	2(2.5)	4.2
	In this method, learning has many added values.	38(47.5)	22(27.5)	19(23.75)	1(1.25)	0(0)	4.21
	Purposefulness of learning in this way is evident.	40(50)	25(31.25)	14(17.5)	1(1.25)	0(0)	4.3
	This teaching method improves the performance of learners.	33(41.25)	35(43.75)	9(11.25)	2(2.5)	1(1.25)	4.21

Table 5: Students' opinion on learning by gamification of cardiovascular pharmacology based on the domain

Domains	Mean	SD	Standard error
Motivational	3.94	0.22	0.09
Enjoyable	4.07	0.21	0.10
Change behavior	3.69	0.14	0.14
Profound learning	4.09	0.26	0.10
Total	3.99	0.25	0.05

Table 6: Students' before and after learning scores

Knowledge	Mean (before)	after	paired t- test	P
	14.7(2.03)	17.06(1.32)	7.66	0.0001

Table 7: Professor's opinion on learning by gamification of the cardiovascular pharmacology course

Question	Very much	Much	Moderate	Low	Very low	Mean
This teaching method plays an important role in motivating the learners.	6(60)	4(40)	0(0)	0(0)	0(0)	3.6
This teaching method enhances the learners' ability to apply in professional environments.	2(20)	8(80)	0(0)	0(0)	0(0)	3.2
This teaching method enhances the learners' self-management ability.	1(10)	6(60)	3(30)	0(0)	0(0)	2.8
By using this teaching method, the learners' confidence reduce.	0(0)	0(0)	0(0)	4(40)	6(60)	4.6
This teaching method contributes to the satisfaction of learning.	6(60)	3(30)	1(10)	0(0)	0(0)	3.5
This teaching method reduces the intrinsic motivation for learning in the learners.	0(0)	4(40)	2(20)	3(30)	1(10)	3.7
This teaching method increases the external motivation for learning in the learners.	3(30)	7(70)	0(0)	0(0)	0(0)	3.3
This teaching method is effective in creating enjoyable educational activities for the learners.	4(40)	6(60)	0(0)	0(0)	0(0)	3.4
This teaching method is effective in creating meaningful activities for the learners.	3(30)	6(60)	1(10)	0(0)	0(0)	3.2
This teaching method improves the learners' behavior and performance.	4(40)	5(50)	1(10)	0(0)	0(0)	3.3
This teaching method enhances changing learners' behavior and performance.	2(20)	7(70)	1(10)	0(0)	0(0)	3.1
Gamification can reduce the learners' social skills.	0(0)	0(0)	3(30)	5(50)	2(20)	3.9
This teaching method will deepen learning for the learners.	0(0)	0(0)	0(0)	2(20)	8(80)	3.8
This teaching method enhances the understanding of the subject of education in the learners.	3(30)	7(70)	0(0)	0(0)	0(0)	3.3
Working in a game framework is fun.	4(40)	5(50)	1(10)	0(0)	0(0)	3.3
Learning through gamecan create indescribable joy and excitement in learning.	4(40)	5(50)	1(10)	0(0)	0(0)	3.3
Proper educational feedback is designed.	1(10)	9(90)	0(0)	0(0)	0(0)	3.1
In my opinion, the intensity of interest in learning decreases with frequent usages.	0(0)	1(10)	4(40)	5(50)	0(0)	3.6
In my opinion, gamification is ineffective in achieving the goals of the healthcare team.	0(0)	0(0)	1(10)	3(30)	6(60)	3.3
Learning in this way is directly depend on the individuals and users' ability and characteristics.	3(30)	7(70)	0(0)	0(0)	0(0)	3.8
The rewards applied in the game are irrelevant and exaggerated.	0(0)	0(0)	2(20)	8(80)	0(0)	3.4
In my opinion, educational games will reduce the performance of the learners.	0(0)	0(0)	1(10)	3(30)	6(60)	2.8
Attempts to play the game may not be for a deep understanding of the subject.	2(20)	4(40)	0(0)	0(0)	0(0)	3.8

DISCUSSION

The results of gamification showed that, using gamescan affect students' learning,motivation, and satisfaction. Also,teachers' opinions were positive on all learning dimensionsand students'sskills from gamification design and using it by students.

Today, in gamification designing, game-based learning becomes one of the most popular subjects in education. Although early studies have focused on the negative aspects, and consequently, on the negation of the game media, the field of research has now focused on its usefulness and its positive aspects[9].

Some evidence showed that, thelearners with online game-based learning environment (GBLE) perceived a significantly higher level of intrinsic load, due to the novelty of the subject matter[10].

In a review study by Faiella et al. (2015), it was shown that, using gamification must be correct, strategic, and appropriate to game elements, so that it can create a learning situation in active participation and in a high level. It can also produce a positive result in the cognitive, emotional, and social domain[11].

The result of the present study also shows that, gamification may have a positive effect on the students' learning. The results of O'Leary's study in comparison of satisfaction and learning by the traditional method and educational games in teaching subject of ectopic pregnancy showed that, the students' scoreswere higher than the scores of traditional learning, and their interaction-remembering- enjoyment was more than that of the other methods of traditional learning. In our study,the students also scored better in exams after the games[12].

In the study byJui-Mei Yien et al., the effect of using a game-based learning approach was investigated on nutrition education. This study also showed that, the results are consistent with the present study,and that learning in a group of students using the game was much better than the group with traditional learning[13].

In a study by Ming -Puu Chen et al., they examined the effects of game strategy on the experience of novice students and learning performance using empirical game activity. The results of this study showed that, the performance of students using educational games increased[14].

Recent study indicated that, designing multi elements have positive effects on students learning, motivation, and enjoyment from learning. Also, teachers' perceptionsof this educational program were positive. They reported that, this program has an ability to develop self-management;be applied in professional environments; satisfaction of learning; creating meaningful activities; increasing the behavior,performance,and social skills; and changing learners' behavior and performance.

This resultswere also confirmed by another research.

Game design elements can be used to enhance the learners' feelings of relatedness, autonomy, and competence to foster the learners' intrinsic motivation[15].

The increasing effect of technology on all aspects of life including at the education level, has made it necessary for the country to focus on advancing in the field of higher education through adopting new educational systems and technologies. Nowadays, most universities try to increase the effectiveness of emerging the technologies in their educational activities[16].

Therefore, the student creates ideas to form new knowledge. This use of play allows the student to get more information beyond the available one. Modern theorist, Robert Gagne, also agreed with constructivists who believed that, the games are important during the learning process[17].

Another research reported that, the games provide communication between learners in an enjoyable and attractive environment and motivate them to learning[10].

In a study by Seixas et al. (2016), they examined the effectiveness of gamification on student interaction. They found that, gamification had a positive effect on student interaction, and these results are consistent with the findings of the present study[18].

Also, Atmacasoy and Aksu (2018) in their review study of Turkish universities found that,blended learning by game had a positive effect on students' motivation and success[19].

Another researcher reported that, using game mechanics had a positive impact on the students' motivation to engage in more challenging activities during the course. In the present study, gamification was also effective on the students' interaction in the classroom[20].

Another study showed that, game in education have efficacy andimprove the learning,the students' satisfaction, and deep understanding of concept[21-25].

All the above-mentioned results were confirmed by qualitative assessment of gamification on students. Overall, review of articles showedthat, a game-based learning approach may beeffective on facilitating the students and ready them to 21st century skill development[26].

CONCLUSION

Considering the designing and experimental works on students' sample and examining their effects on learning/satisfaction and motivation in pharmacology, it can be stated that, using innovative and active ways of engaging students in their learning and creating an attractive and enjoyable environment can help the students to learn effectively and deeply, and can also provide enjoyable learning in a motivational environment. More research is need to approved effects of gamfication on learning indicators and another effects .

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