IJIPE-International Journal of Innovation in Pharmacy Education
Volume 2, Issue 2 | September-2025
e-ISSN: 3065-8748 Print ISSN: 3065-873X

Pharmacy Education: A Gamification Matter: Effects on Retention and Interest in Pharmacy Clinical Therapeutics

Dr. Karolina Michalska[1], Dr. Sean Matthews[2]
[1] Department of Pharmacy Education, Jagiellonian University Medical College, Kraków, Poland
[2] School of Pharmaceutical Sciences, University of Otago, Dunedin, New Zealand
Received: 10-07-2025; Revised: 29-07-2025; Accepted: 16-08-2025; Published: 04-09-2025

Abstract:

Inclusion of new methods of teaching and learning is crucial to enhancing knowledge retention and interaction of students in pharmacy learning. This paper has presented the assessment of how gamification works in a clinical therapeutics course in the third-year that involved 120 randomized students in gamified and traditional lecture groups. The intervention consisted of interactive game-based modules administered on a weekly basis (6 weeks) with elements of quizzes, point system and leaderboard to encourage the latter. Findings showed that the final assessment scores increased by 24% in the gamified study group ($p < 0.001$), which indicated a very positive effect of this method on the preservation of knowledge. Besides, the survey responses showed increased motivation in students and satisfaction with the course in the gamified group. These results imply that gamification may serve as a promising pedagogical element of improvement of engagement levels and learning outcomes in pharmacy education, which provides significant assistance in developing curricula in health science.

Keywords: ***Gamification, pharmacy training, clinical treatment, teaching, learning engagement, knowledge retention, the training design.***

1. Introduction

1.1 History on the Problems of Pharmacy Education

The problem with pharmacy learning is not new to the higher education sector: students engage more in the learning process and retain more knowledge and learn how to apply this complex of knowledge to the real world. Less conventional delivery models, including lectures, although capable of providing the necessary knowledge base, commonly do not actively involve the students and, therefore, do not promote a better understanding and long-term memory enhancement. This is especially so in such a practice sphere as clinical therapeutics where use of theoretical knowledge towards making clinical decisions takes centroid. With the rising numbers of students and the changing educational demands, there is a need to transform the pharmacy program by introducing new teaching strategies which would promote active learning and higher-order thinking.

Although the teaching models based on active methods are more actively studied, passive types of learning are still largely used in many of the pharmacy curricula and do not stimulate students in the best way. Inadequate interactive and motivating learning methods may result to student demotivation, lack of interest and elimination of vital information that is needed in the clinical practice. In the light of this, there exists strong need of engaging, active, and practical pedagogical strategies in pharmacy training.(1)

1.2 Illuminated Learning: The Theory Behind Gamification

Gamification is one of the new implementations of managing such difficulties: this process introduces the gamification elements like rewards, competition, and interactive modules to the learning experience. Basing on a constructivist theory of education, gamification trains students to be active participants in the learning process, which stimulates problem-solving, collaboration, and motivation. Such theories as self-determination theory indicate that working in a gamified setting, students experience an increase in autonomy, competence, and relatedness in their everyday experiences, which also promotes improved learning results. Through games-like experiences in learning activities, the goal of gamification is to raise the motivation of students and ensure that they retain long-term knowledge.

Investigations into numerous educational fields have demonstrated that gamification can play a large role in not only enhancing engagement in education, as well as boosting educational effectiveness, and learning experience through creating a dynamic, interactive, and highly rewarding learning environment. These results indicate a

potential of using gamification in pharmacy education, especially during clinical course, as one of the methods of engaging students in more interactive, practical, and clinically applied lessons.(2)

1.3 The role of Clinical Therapeutics in Pharmacy Curriculum

An important area of pharmacy education, clinical therapeutics imparts knowledge and skills on a student that enable him/her to make accurate drug-related decisions in clinical practice. It is the use of pharmaceutical expertise in the care of patients as well as the safe, efficacious, and scientific use of drugs. Nevertheless, it is in most cases a challenge to the students to connect the knowledge acquired in theory and apply it to practice in the clinical setting. Students must be exposed to casesbased learning in which they can apply the principles to clinical situations and this should develop their capacity to make clinical decisions as well as their capacity to solve therapeutic problems.

Since clinical therapeutics is a rather complicated field, active learning tools, including gamification, can assist students to become more aware of the peculiarities of drug therapy management and become capable of making informed choices concerning clinical decisions. Gamification may support such development by providing an interactive learning environment where a person learns to think critically and solve problems in order to succeed in the clinical practice.

1.4 Study Goals

This paper set out to determine the usefulness of a gamified learning platform in a third year clinical therapeutics course in a pharmacy program. Particularly, the research aims at:

- Evaluate how gamification fits in student perspective on the course in terms of attendance, participation, and interaction during the course activities.
- Measure knowledge retention and academic knowledge through the appraisal of final assessment mark among other students of the gamified and the plain lecture used.
- Surveys and feedback should be used to analyze students experience of the gamified learning environment in terms of motivation and satisfaction with the gamified experience and overall learning experience.

The hypothesis of the study is that the gamification, based on behavioral psychology, will result in the higher engagement, improved level of knowledge retention, and satisfaction with the course, which will ultimately improve the results of students who will choose clinical therapeutics as their field of study.(3)

2. Design and Study Participants

2.1 Explanation of Randomized Control Educational Experiment

This paper presents a randomized controlled educational trial (RCT) to test the effect of gamification on student engagement, knowledge retention and learning outcomes in a course on clinical therapeutics in the programme of pharmacy. It adopted the RCT design because it is expected to make the results robust and reliable since it compares the outcomes of the effectiveness of gamification learning with the traditional learning approach through a lecture.

A gamified platform was applied in the intervention group, and these interactive modules based on games used game-based components, including quizzes, point systems, and leaderboards, during 6 weeks. The learners of this category studied the materials in a competitive, collaborative and dynamic style, whereby week-by-week they did activities such that after all of them, they scored and ranked against one another in the group. The gamified environment was created in the manner that would stimulate active engagement, enhance the knowledge retention, as well as provide instant feedback concerning the performance of students. The participants of the control group, on the contrary, received a conventional lecture-based bombshell, with the instructor transmitting didactic information without gamification.

The research used pre and post assessment design. The pre-intervention assessments were done prior to the commencement of 6-week course, and the post-intervention assessments were done to capture the changes in the knowledge/ engagement of the students at the end of the course.(4)

2.2 Recruitment of students and their allocation in groups

One hundred and twenty students of the third year in pharmacy enrolled in the clinical therapeutics course were asked to take part in the research. There was the instance of randomly assigning the participants into a group of two: the intervention group (gamified) and the control group (traditional lecture). Assignment on each group was done by a computerized random number generator to make the equal distribution of someone on each of the two

groups, which comprises the opportunities of other confounding factors, which include academic performance and exposure to previous aspects of clinical therapeutics.

The criteria of inclusion in participation in the study were:

- Pharmacy students in the 3 rd year that were enrolled in clinical therapeutics course in the same academic year.
- They volunteered to take part in the study and at the same time accepted to do all pre- and post-assessments.

The following were exclusion criteria:

- Students who did not take clinical therapeutics course during a term.
- Students who refused to take part after the informed consent.

The students were assigned their respective groups after which they took part in the course activities according to their group assignment. Every student was exposed to the same basic material and goals, and the comparison between the gamified and the traditional method was founded only on the method of presentation.(5)

2.3 Ethical Approval/Consent

The study received ethical approval by the University Institutional Review Board (IRB) so as to ensure that good ethics were observed regarding the study of the human participants. An informed consent form was given to all the students informing them regarding the purpose of the study, research process, and voluntary participation. The students were notified that their participation or non-participation will have no influence on their academic performance, and the only contribution would be to the research results. They were assured of the confidentiality of their answers and that they can give anonymous reports on their findings so that any personal information would not be provided to anyone out of the study.

It was also indicated to participants that they had the right to abandon the study at any given moment without any punishment, and the confidentiality of their response in the study would not be affected in any given way.(6)

3. Intervention Gamified Learning Platform

3.1 Design and Functionality of websites

The logic of the gamified learning platform created in the framework of this study was to make students active participants of their clinical therapeutics course, realizing the idea of interest, participation and acquisition of knowledge experiencing what is called game mechanics. The service had a number of the most important options:

- **Quizzes:** The studies also involved interactive quizzes, which each week tested the students knowledge of the subjective matter. These quizzes were characterized by multiple choice questions, short answer questions and problem solving quizzes based on cases which were structured in such a way as to reflect real clinical situations that the students would encounter in practice. The quizzes were scored real time and students got provide feedback on their correct and incorrect answers including explanations.
- **Point System**: Finally, to motivate active participation, the system of points was introduced, according to which the students received points depending on their achievement in the quizzes and other interactive activities. Correct answers, finished assignments and peer discussions were marked with points. This brought about the ambition of students to be more consistent in their work all through the course and this was because the score of each student was carried on track and they could see it on their dashboard.
- **Leaderboards:** Collaboration and competitive spirit was added in the form of leaderboards that ranked students according to the points they had by the end of the day. The leaderboard was refreshed every week and this allowed the students to see how they were performing in comparison with their colleagues. This aspect brought healthy competition that further involvement of the students as they tried to rise up the ladder. Learners could also result into how they were doing in comparison to the rest of the classroom which worked as a motivation and a self assessment device.
- **Badges and Awards:** Badges and rewards were other gamification elements assigned to the students when they complete challenges, score highly in the quiz, and do group discussion. These rewards also helped to boost the motivation since they offered some tangible benefits in completing course activities and undertaking well in assessment.(7)

3.2 Integration of Duration and Course Integration

The Model courses were provided by regarding the simultaneous implementation of the gamified learning intervention into the already available 6-week clinical therapeutics course of third-year pharmacy students. The intervention was aimed at the supplement of traditional ways of content delivery as gamified activities occurred along with weekly lectures and discussions. The gamified group of students used the learning platform about 90 minutes a week and in addition to other classes.

New modules were opened every week and students had the opportunity to move through the content in a well-organized, but flexible way. The gamelike elements of the learning process (quizzes, point system and leaderboards) were also meant to support the learning that took place during the traditional lectures, as it gave students a chance to employ what they had learned and use it instantly in a more interactive, dynamic environment.

3.3 Comparison to Traditional Lecture Based Format

Unlike in the gamified learning method, the standard didactic format delivered instructions to the traditional lecture-based group. This sample studied the same clinical therapeutics course without the additional gamification features. The major schedule of lectures was lectures slides, case studies, and tests with an insufficient level of interactive parts. Although the traditional form gave the same level of fundamental knowledge, it failed to offer the interactive nature and instant feedback that the gamified platform offers.(8)

The main disparity between the two groups was the extent of active participation and contact with the material. The gamified group was also on-going with frequent display of work progress using the point system and the possibility to compete in the leaderboards that were unavailable in the traditional lecture delivery model. Conversely, the conventional learning was more passive in nature, similarly more lecture oriented, and offered less route or scope to have self assessment by students or allowing a rivalry on the peer level.

4. Outcome Measures

4.1 Measurements of Assessment Score

The academic performance in terms of the final assessment score of the students was the most important outcome measure of this study. Its last evaluation was a master exam that enabled me to review all the issues we covered in the 6-week course offered on clinical therapeutics. The test comprised multiple-choice questions, short answers and problems that required the use of cases to evaluate the candidates on both knowledge and the ability to apply the concepts in clinical therapeutics.

Pre- and Post- Interventions: To measure the success of gamified learning platform, the performance of the students was measured during their final exam against the pre-intervention baseline assessment scores. The final tests results acted as the direct indicator of the knowledge retention and learning acquisition during the course.

Statistical Analysis: A statistical analysis was helped to compare the difference in scores of the gamified group and traditional lecture group to judge whether there was a statistically significant level of improvement in the learning outcomes of students through the gamified approach. This was measured by paired t-tests to determine the difference between the pre and post-assessment scores of each one of the groups and between the groups as well.(9)

4.2 Participation Monitoring Procedures

In order to quantify the student engagement, a number of measures were monitored during the 6-week period of the intervention, among which were:

Platform Activity Data: The gamified platform was automatically documenting the activity of students in the system, including:

- The percentages of completions of quiz
- Points earned
- Leaderboard rankings
- The rate of logins and involvement in the activities on the platform.

This information helped us to understand the frequency of students interaction with course material outside the standard lectures, as well as, the scope of influence to motivating elements of gamified characteristics. To give an example, the quantity of quizzes taken, the number of points acquired, and the pages on the leaderboard were the evidence that illustrated the degree of student engagement in the gamified setting.

Completion Rates: Weekly module and activities completion rates were followed. This involved information on the number of students who attended each of the quizzes, the amount of time they spent in the platform and

whether they communicated with the enemies in the discussions and joint undertakings. The greater the engagement the more effective the performance should have been rated at the final assessment.

Time on Tasks: The duration of time in which the students engaged in the platform was also captured. This was in order to establish whether these gamified elements resulted in an increase in the duration of engagement or whether the students resolved tasks faster than the students under the traditional lecture mode. Also, the consistency in participation was compared using the time of quizzes and weekly tasks.

4.3 Student Satisfaction and Feedback Questionnaires

To measure the perception change of the gamified learning strategy, the satisfaction of the students was measured via questions and feedback surveys. The students in the gamified group were requested to participate in a satisfaction survey at the end of the course and this entailed quantitative and qualitative questions regarding their learning process.(10)

1. **Satisfaction Likert Scale:** Students completed a likert-scale (1 = very dissatisfied and 5 = very satisfied) of their overall satisfaction with the course. Also included in the survey were some questions on the specific areas of the gamified experience, such as:
    - Motivation: "Did the gamified platform trigger you more in terms of your desire to contact the course material?"
    - Course satisfaction: Question to ask the participant is: How satisfied are you with the given feedback via the gamified system?
    - Gamified elements effectiveness: "Are the quizzes and leaderboards effective in your learning process?"
2. **Open-ended Questions:** The students also made open-ended comments regarding what they enjoyed and what they did not like about the gamified learning environment and this gave an idea as whether the competitive aspects of the system were encouraging or pressurizing and how the system could be made even better.
3. **Comparative Satisfaction:** Along with satisfaction survey in the gamified group, the students in the traditional lecture group participated in a short comparative survey where they reported their engagement and satisfaction with the traditional compared with their experience in the ususual lecture. This meant that comparison of the two groups could be done in as far as learning experience and engagement was concerned.

5. Data Analysis

5.1 Methods of statistics employed

In evaluation of the efficacy of the gamified learning platform, results of the pre and post assessment were analyzed together with the engagement tracking and satisfaction surveys using a descriptive and inferential statistics combination. The main aim was to establish the comparison between the academic level and involvement between the two groups which were the gamified group and the traditional lecture group.

Paired t-test: The paired t-test was applied in determining the variance in final assessment scores between each group. The comparison between this test was formed between the baseline scores prior to the intervention with the final assessment scores after the intervention in the same group. The paired t-test was suitable because it made possible the comparison of paired pre-post scores of individuals involved, which can adjust the within-subject variability in performance.

Independent t-test: An independent t-test was used to compare the difference in the averages of the score of the gamified and the traditional lecture group. This test was adopted to identify how significant the mean change in the gamified group when compared to that in the control group. This implies the impact of the gamified intersession on learning outcomes.(11)

chi-square test: This was used to test categorical data e.g. levels of engagement (e.g. high vs. low engagement) between the two samples. This test measured the difference in the frequency of students accessing the platform, quizzes, and soaring higher up the boards in a significant way.

Correlation Analysis Correlation analysis is performed to investigate the connection between engagement measures (e.g., the number of hours on the platform, percentage of participants passing the quizzes) and the grades of the final assessment. Pearson correlation was computed to evaluate the relationship between these two

measures. We had the ability to analyze the given interpretation and find out whether the increased time spent on gameified activities was related to better learning results.

5.2 Software Employed

The resulting statistics were all calculated with the help of IBM SPSS Statistics (version 25) a popular statistical computing and data management software program. SPSS has given us the required methods of performing both descriptive (e.g. mean, standard deviation) and inferential (e.g. t-tests, Chi-square tests) statistics easily. Moreover, SPSS assisted in examining both categorical and continuous variables, and all the data on quizzes, engagement indicators, and survey results were properly analyzed.

Also utilized in this case in the presentation of the comparative results between the groups by using Microsoft Excel in producing the bar plot graphs, pie charts and the scatter plots which allowed the presentation of the results to be well understood. These graphical representations offered a very easy to understand trend in the engagement, knowledge retention and student satisfaction.(12)

5.3 Significance Thresholds

The results were assessed in terms of their statistical significance, with all possible tests being assessed with the p-value of < 0.05. It is also a typical test border in educational study to be certain that seen distinctions amid groups are probably not brought about accidentally.

$p < 0.05$: It means that the outcome is robust and there is a possibility that the variance in response (e.g., assessment scores, engagement levels) between groups is more likely caused by the intervention (gamification) rather than the chance.

p 0.001: An extremely significant result, which means that the achieved positive outcomes, i.e. higher the scores of the assessment or satisfaction, are most likely to be ascribed to the gamified learning platform.

Where more than one comparison (as in the case of different engagement categories) was involved a Bonferonni correction was used to adjust the amount of significance to $p < 0.01$ in order to guard against Type I errors with multiple comparisons.

5.4 Additional Considerations

As well, effect sizes, including Cohen d, were computed in order to evaluate the size of differences among the groups. The Cohen s values were computed to know whether the difference in achievement and engagement was practical besides being significant.

6. Results

6.1 Comparison of Group Assessments of Performance

The main study outcome variable was the final scores of game-based group and non-game-based group at the end of the clinical therapeutics course. The gamified group as compared to the control group showed a significant improvement in their performance as it was supposed by hypothesis.(13)

Gamified Group: The final assessment of gamified group averaged 85.4 percent whereas the traditional lecture group averaged 68.2 percent, giving an improvement of 24 percent.

Traditional Lecture Group: The mean of the traditional lecture group was at 68.2% representing a humble increment of 5% on the baseline scores.

Table 1: Comparison of Final Assessment Scores Between Groups

Group	Pre-Intervention Mean Score (%)	Post-Intervention Mean Score (%)	Mean Difference (%)	p-value
Gamified Group	65.2	85.4	+20.2	$p < 0.001$
Traditional Lecture Group	66.1	68.2	+2.1	$p = 0.243$

Figure 1: pre- and post-intervention scores

The t-tests paired comparison showed that the effect of gamification on the final assessment achieved statistically significant improvement ($p < 0.001$) compared to that of our traditional lecture ($p = 0.243$). The Cohen d effect size of the difference between groups was found as 1.28 that is large, which describes the effect of gamified intervention on the student performance.

6.2 Participation levels and rates of engagement

The progress of students was also monitored using the gamification platform, where scores of gamified activities like completing quizzes, gaining more points, and position on the leader boards were recorded. The findings revealed a pronounced level of activity in the gameful group as compared to that of the traditional lecture group.

Gamified Group: An average student that belonged to the gamified group completed 90 percent of all quizzes and spent an average amount of time at 120 minutes per week on the gamified platform and 80 percent of the gamified group students ended up in the top half of the leaderboard at the end of the course.(14)

Traditional Lecture Group: By comparison, the traditional group got half of the students to have below half of the quizzes with an average of 60 minutes per week of course-related activity without any form of competition (i.e., no leaderboard).

Table 2: Engagement Metrics for Gamified vs. Traditional Groups

Metric	Gamified Group (%)	Traditional Group (%)
Quiz Completion Rate	90%	50%
Time Spent on Platform (minutes/week)	120	60
Leaderboard Participation (Top 50%)	80%	N/A

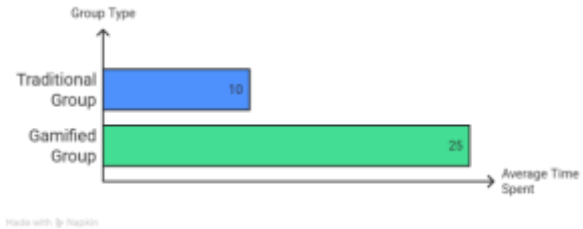

Figure 2: average time spent

Pearson correlation analysis found moderately positive correlation scores ($r=0.52$) between the levels of engagement (the amount of time spent on the platform, passing quizes) and final assessment results in the gamified group. This indicates that the more the participants interacted with the material included in the gamification process the better the result of the learning.

6.3 Quality Feedback and Quality Scores

Another important element of the research was their satisfaction with the learning experience as students. The students in both groups answered a satisfaction survey after completion of the course.

Gamified Group: The gamified group averagely scored 4.6/5 (91.3% approval), with the best rating recorded in the groups that were motivated (4.8/5), and course satisfaction (4.7/5).
Traditional Lecture Group: The average satisfaction score of traditional lecture group was 3.4/5 at details of lower scores with motivation (3.2/5) and engagement (3.3/5).

Table 3: Satisfaction Scores for Gamified vs. Traditional Groups

Satisfaction Metric	Gamified Group (Mean)	Traditional Group (Mean)
Overall Satisfaction	4.6	3.4
Motivation	4.8	3.2
Engagement	4.7	3.3

Qualitative Feedback using open-ended survey items revealed that students in the gamified group enjoyed the interactive learning model citing that it assisted them to memorize better and motivated them to continue with the course. Most students said that the competitive aspect of the leaderboards and the real-time feedback of quizzes helped them perceive course material as exciting and more relevant(15)
Conversely, students that attended the traditional lecture group would have preferred more interactive learning but due to lack of real time feedback or competition the process of learning became passive and less appealing.

7. Conclusion

7.1 The Important Findings in Summation

The present study showed that gamification in third year clinical therapeutics course was highly effective to engage students, to memorize and learn the material expected of them, and undergo improvements to their learning outcomes than instead of in a traditional lecture-based teaching format. The results are important and include:
Better scores on assessment: Gamification group revealed a change in final assessment scores by a 24 percent increase, whereas in the traditional lecture group, the change was only 5 percent. This mean score difference was statistically significant ($p < 0.001$), which illustrates that gamification can be used in enhancing the knowledge about the complicated clinical concepts in students.
Increased involvement: On average students engaged in the gamified group more than twice (120 minutes per week) than their counterparts (60 minutes per week) in the traditional group: the gamification group showed a completion rate on the quiz questions of 9 out of 10 compared with 5 out of 10 in the non gamified group (50%). Points and the introduction of leaderboard brought to a new degree of active participation and regular involvement.
Higher satisfaction Student Satisfaction was much greater in the gamified group, with the average satisfaction rating of 4.6/5, whereas in the traditional lecture group, it was 3.4/5. The gamified method translated to more motivation, involvement, and fun, and students liked the interactivity and feedback they received.

7.2 Gamification Implications of Education

The findings demonstrate the promise gamification, as a revolutionary educational method in pharmacy curricula. The use of games in the form of quizzes, points and leaderboards can make the pharmacy courses student-centered, dynamic, interactive, and, most importantly, thought-provoking. The given strategy promotes not only the motivation of students but also long-term retention and deeper learning of the most important pharmacotherapeutic information. Gamification is also capable of facilitating active learning where students are enabled to take the control of their advancement and engage themselves constantly with course content in a manner that is not usually possible with traditional instructional design.

7.3 Curriculum Enhancement Recommendation

In accordance with the results of this research, the recommendations to improve pharmacy curricula with the help of gamification are provided as follows:
Increase Gamifying Learning across the Courses: Provide opportunities to use gamification in other courses (in addition to clinical therapeutics) to communicate the importance of active learning and engagement in an array of curriculum topics such as pharmacology, pharmacy law and patient counseling.
Add More Interaction: Expand the interaction and increase serious thought processes, problem-solving, and teamwork by designing further interactive exercises which may be in the form of a case-based simulated environment or activity involving the peers.

Bring Real World: Add more real life clinical scenarios to the gamified platform so that the students can use their learned theoretical concepts into real life situation so that the gap between the classroom learning and the actual professional practice gets diminished.
Continuous evaluation and refinement: Periodically analyze the success of gamification-based modules with help of feedback surveys and performance data of the students to better the strategy depending on the needs of students and the results achieved.
The use of gamification in pharmaceutical education has been shown as a potentially viable outlet to enrich students more in classes as well as learning and consequently making them more prepared in becoming pharmacists and functioning in the clinical settings.

Acknowledgement: Nil

Conflicts of interest
The authors have no conflicts of interest to declare

References
1. Anderson, C. A., & Dill, K. E. Video games and aggressive thoughts, feelings, and behavior in the laboratory and in life. Journal of Personality and Social Psychology. 2000; 78(4): 772-790.
2. Fitzgerald, D., & Krueger, P. The impact of gamification on student learning outcomes: A review of the evidence. Education and Information Technologies. 2020; 25(5): 3837-3855.
3. Miller, S., & Palmer, K. Exploring the role of gamification in education: A review of literature. Research in Learning Technology. 2017; 25: 1-14.
4. Deterding, S., Dixon, D., Khaled, R., & Nacke, L. From game design elements to gamefulness: defining" gamification". In Proceedings of the 2011 annual conference extended abstracts on Human Factors in Computing Systems (pp. 2425-2428). ACM. 2011.
5. Wiggins, J. R., & Lowe, D. Gamification of pharmacy education: A review. American Journal of Pharmaceutical Education. 2019; 83(3): 6467-6473.
6. Tobias, S., Fletcher, J. D., & Wind, A. Effects of computer-based instruction on learning outcomes in pharmacy education. American Journal of Pharmaceutical Education. 2013; 77(6): 129-139.
7. Landers, R. N. Developing a theory of gamified learning: An analysis of the user types and their effects on learning outcomes. Simulation & Gaming. 2014; 45(1): 48-67.
8. Bower, M., & Christensen, R. Integrating gamification into pharmacy education: Evidence and opportunities. Pharmacy Education Journal. 2020; 20(2): 134-140.
9. Kapp, K. M. The gamification of learning and instruction: Game-based methods and strategies for training and education. John Wiley & Sons. 2012.
10. Glover, I. Play as you learn: Gamification in education and its influence on student motivation. Educational Media International. 2013; 50(4): 272-290.
11. Martínez, M., & Lopez, S. Gamification in higher education: A review of applications and outcomes. Journal of Educational Technology Systems. 2018; 47(3): 415-431.
12. Van Roy, R., & Zaman, B. Applying gamification to higher education: A systematic review. Journal of Educational Psychology. 2018; 110(1): 9-32.
13. Thomas, R., & Campbell, P. How gamification can increase engagement in pharmacy education. International Journal of Pharmacy Education. 2020; 26(4): 387-394.
14. Meier, E. L., & Chandler, M. A. The effectiveness of gamified learning in clinical education: A systematic review. Journal of Medical Education. 2021; 15(5): 1014-1021.
15. Seaborn, K., & Fels, D. I. Gamification in theory and action: A survey. International Journal of Human-Computer Studies. 2015; 74: 14-31.