

Game-based Assessment in Educational Institutes

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Abstract

Game-based assessment is a method that may be applied in educational institutions as the use of technology creates new possibilities. Therefore, students need to keep abreast of all these developments and ensure that they are exposed to digital media not only for entertainment, but also for education and learning. It is likely that game-based assessment will be used even more in the future and be a part of student assessments due to its efficiency to enhance students' performance, reduce levels of stress and anxiety during assessment, and provide possibilities for measuring the reliability of students' skills compared to traditional assessment methods. This paper first presents a literature review of game-based assessment as a modern method evaluating learners to verify their proper progress in terms of the educational process followed by introducing part of the theories that support this kind of assessment. The paper also discusses some of the advantages and disadvantages of using this type of assessment to evaluate students of different levels. Finally, this paper sheds light on some examples of the effective use of game-based assessment approach to demonstrate the success of this type of assessment and concludes with important suggestions for educators interested in game-based assessment.

Keywords: Game-based , Educational Institutes

Introduction

Learners may struggle to engage during the learning process, which suggests the existence of obstacles somewhere in the learning procedures. One of these obstacles may be the lack of students' motivation and here comes the role of educators, who persuade and generate motivation for learners. A form of stimulation that may create motivation for learners is game-based assessment, in which the teacher departs from the traditional method, that depends entirely on rote learning and memorizing by heart. On the other hand, using game -based assessment thorough various types of multimedia and entertaining thinking motivates

students to learn and help them to interact and promotes more desirable learning.

Game-based Assessment

The idea of integrating games into education began after digital games started to take over the lives of young people, who spend hours playing these games. Therefore, it is imperative for educators to find ways to use digital games correctly and integrate them into educational curricula and learning processes. Several studies have found that games reflect the way in which they are played by a human mind's design for learning, an element that motivates the learner to complete challenges, face problems, and make appropriate decisions. In addition, games inspire in the learner the spirit of perseverance when failing and achieving increasingly challenging goals. Furthermore, playing games must devote attention, time, and effort to acquiring knowledge and skills. All these benefits are achieved while the student plays the games, in which learners' achievements and skills in the educational processes are evaluated ⁽¹⁾.

Consequently, the idea of assessment using games instead of traditional methods has had a significant impact on creating motivation among students and avoiding tension and anxiety that may occur among students when completing traditional tasks. Instead, students' participation in multimedia design and game development tasks will allow them to collect, organize, and analyze information based on their understanding of the learning content and their interpretation of educational tasks, allowing them to interact and participate continuously with learning tasks and contexts, which plays a significant role in helping learners to build new knowledge and develop problem-solving skills ⁽²⁾. According to Papastergiou games are powerful learning tools as they support active, multi-sensory learning based on problem solving and critical thinking. Furthermore, games also activate learners' previous knowledge and educational attitudes and urge them to successfully confront recent situations and improve students' social skills by creating persistent collaborative learning

environments. Finally, games support decision-making through feedback and providing opportunities for self-evaluation⁽³⁾.

Game-based Assessment Foundations

Many educational and researchers have called for the integration of games into the learning process, as educational games play an important role in the development of the mental, physical, social, emotional and linguistic aspects of learners. Therefore, the design of these games must follow specific foundations and standards to achieve the desired educational goals, motivate learners to learn and make the learning environment a fertile environment for students. One of the theories and educational foundations that must be taken into account while designing games for learning and assessment purpose is the constructivism theory, where this theory is part of the modern thinking that is attributed to Jean Piaget. It can be said that it is the process of reconstructing learners of new meanings within the context of their recent knowledge along with their previous experience. There is also a basic principle of the constructivism theory which is learning is an active process in which the learner exercises his/her activity while processing information, modifying and changing his/her mental environment so that student is able to make a mental effort to discover knowledge completely by him/herself. For example, when students are involving in educational game, they make a mental effort trying to discover the solution by themselves to reach the goal, whether it is moving to the next stage, reaching the solution or the treasure, which is the end of the game. During this process, the learner builds learning based on what was previously known from the educator, in addition to the new experiences he/she gained by encountering real situations, tasks and problems⁽⁴⁾.

Another main model that games designers should pay attention to while designing games for evaluation purpose that is based on concept of activity theory is Activity Theory-based Model of Serious Games (ATMSG). Whereas activity theory presents an organizing framework that considers the game not

only as an isolated tool, but also as part of a complex system consist of human (player - learner - game designer) as well as motivations that drive them to interact with the games. The ATMSG model can be used in the early stages when prototyping the games so designers can determine whether the perceived game structure supports the desired educational goals or not. When using this model, the activities are divided into actions and the game into smaller parts. Also, each activity is divided into a series of actions that mediated by tools with specific goals. The researchers (Carvalho et al., 2015) proposed a four-step approach that guides incrementally the application of the ATMSG model to analyze serious games and gain a well understanding of how learning occurs while playing games. The first stage begins with a description of the main activities involved in the activity system and identification of the corresponding topics and motivations. Followed by the stage of representing the game sequence using a diagram that represents the game sequence in an approximate timeline and this diagram serves as a reference point to reveal the components of the activity system. In the third stage, procedures, tools, and goals are defined, at this level, each event in the game is analyzed into actions, tools, and goals together and in each step of the game the questions will be: "What does the subject do, how, and why?" The last stage is the stage of describing the implementation, which is the stage of assembling all the procedures, tools and objectives of the same type of activity and related to the same node of game sequence. Along with detailed description and explanation of all tools and their purposes as well as the game objectives, each activity has a separate file containing all details. Finally, by integrating all four steps, a comprehensive file and a complete view of the high-level game structure will be available and ready for the concrete implementation process ⁽⁵⁾.

There is also a framework considered as the most prevalent frameworks in game-based assessment design that is Evident Center Design (ECD) which is a framework formulates the process of test development to observe the validity and evidence

collection from the begging of test design phase. This approach has been built on the basis that the test is a measurement tool to which specific claims about test scores are linked, and that a good test is a good match between test elements and the skills of test takers. The work of ECD framework also identifies three core models that are interrelated: the student model, the evidence model, and the task model and the combination of the three models called: Conceptual Assessment Framework (CAF). Whereas student model defines skills, knowledge and abilities, this model can be simple and contain a single skill or a map of interrelated sub-skills. Then comes the role of task model, while the latent competencies cannot be detected directly, tasks or test items must be designed to extract behaviors that reflect the latent competencies. Evidence models make a connection between potential competencies identified by student model and observations (behaviors) extracted by task model. It also includes the results of measurement, which consists of evaluation models, method of recording grades, and statistical method for obtaining total grades ⁽⁶⁾ .

In addition to what was previously mentioned, there are also many theories and frameworks that support game-based assessment like Learning Styles Theory, where this theory focuses on identifying the learning styles of learners (visual, auditory, reading and writing style) so that it become easier for educators and game designers to formulate appropriate educational situations and strategies, design games that fits learners' styles and effectively achieves learning goals. One of the most widely used theory in school environment is Behavioral theory, the concept of this theory revolves around the learning process axis in acquiring new learning, returning it or canceling it and the individual's behavior is subject to modification or change by creating specific educational conditions. One important applications of this theory that teachers while using game-based assessment can employ the formation of desirable good habits. Whereby good habits, attitudes and study materials can be formed

by pairing them with activities that are popular with students as well as the development of some aspects of linguistic behavior by designing games related to the linguistic aspect development, for example, pairing videos and pictures with word and pairing word with reinforcer. Finally, this theory also concerned with treating schools fear by removing the frightening stimuli for children, providing motivating stimuli to students and intensifying the reinforcers. The evaluation by educational games is one of the motivating stimuli for students, which help them overcome the fear and anxiety from school ⁽⁴⁾ .

Game-based Assessment Challenges

Game-based assessments have faced a number of challenges. For examples, several studies have found that, despite the attractiveness and effectiveness of games designed for the purpose of assessing student performance, there is still a lack of reliable methodologies and repeatable mechanisms that measure effectiveness. Therefore, educators and policymakers need to guarantee that games are effective for use in classrooms; using this type of assessment techniques with serious games provides stakeholders with objective, reliable data ⁽⁷⁾ . Ifenthaler, Eseryel and Ge also argue the use of ratings in games is still fraught with complexity due to the widely differing characteristics of games like, contents, graphics, and technology affordances ⁽⁸⁾ .

One of the limitations of the game-based assessment method is that some important changes may be neglected during the learning process, where the focus is often only on the outcomes. When individual results are compared with the previous results and verified by learners and experts, the method of this assessment does not allow educators to be aware of the reasons for failure and the emergence of inaccurate results. Do poor results mean that the learner does not understand the task required of him/her? Was the task complicated? Was he/she motivated and excited while playing the game? In addition, during the educational evaluation process, it is not possible to obtain immediate feedback.

Countless number of difficulties also arise while designing and analyzing games for assessment due to advances in technology and learning science. The first difficulty lies in collecting multiple experiences during the game design stage as each expert has a unique perspective and different way of thinking, speaking, and solving problems. Designing a GPA may involve trainers, network engineers, software designers, cognitive psychologists, educational technologists, game designers and psychometric experts, as in the game *Aspire*, which was developed for Cisco Networking Academy to achieve several goals. The second struggle appears in the discrete and static tasks, which are the focus of the educational assessment practice and include tests and measurement models that have been developed to address this type of data rather than measuring the effectiveness of performance or demonstrating the choice of strategy. Since it is necessary to deal with technology and hardware while designing and evaluating through games, it is normal to encounter technology-related issues. found that the method of assessing intermediate students in their understanding of science and processes using virtual reality games in school's computer lab was effective. However, considerable difficulties were encountered during the assessment, such as issues with running computer software, shortages in school's electrical circuits, and the inability to run all computers at the same time, which meant that only 14 of 20 students were able to complete their unit, which affected the overall results. Based on the same approach, Smits and Charlier recommend using games widely not only as a learning aid, but also as an assessment tool. This study focused on verifying a reduction of students' anxiety during the test using game-based assessment to evaluate 200 high school students, specifically from grades 11 and 12, to summarize first aid information. It should be noted that these students were enrolled in a first aid training course as a part of their school curriculum. In this study, anxiety was measured twice using Test Anxiety Inventory (TAI) at the end of a test moment: prior to the first aid course and at the end of the course. The students were

divided into two groups, namely the evaluation group and control group. The evaluation group consisted of a game-based assessment and a traditional assessment group using pen and paper, while the control group's task was to judge the results of the assessed colleagues. Following data collection and analysis, the result was that the "games' inclusion in formal assessment can result in a more positive psychological well-being which according to the literature- might lead to higher academic achievement" (Smith& Charlier, 2011, p. 562). The shortcomings of this study were the imbalance in the number of subjects for male and female learners; it was believed that the number of female learners was higher in this study because it was conducted in a healthcare setting. The other limitation of this study was the collection of the assessment data in a specific game board; caution should be taken while developing these results for other estimates based on the games as each game has its own characteristics. Finally, the lack of time during teaching hours was an obstacle in this study since only one method was used to measure the test anxiety. This variable should be examined not only with a questionnaire, but also by interviewing parents, students, and teachers, as well as using longitudinal observations⁽⁹⁾.

Another study also found that the lack of teacher training may be an obstacle to game-based assessment. This study, which was conducted on 10 English language teachers from 10 different secondary schools, found that these teachers had positive perceptions of game-based assessment, but were not familiar with it and did not know how to use it in their classrooms. Therefore, the government must provide training or seminars on game-based assessment to enhance teachers' ability to use it confidently in their classrooms ⁽¹⁰⁾.

Application of Game-based Assessments in Schools

Educators and designers of educational games must bear in mind that, when designing games, care must be taken to assess the full range of learners' skills and abilities through the

interactions within the game. During game-based assessment, learners play through a rich series of related actions relying on the skills and competencies that are to be assessed, such as critical thinking, problem solving, and collaboration, which may conflict with a product in an activity, a standard in educational environments that is completely unlike what happens in traditional tests, which are designed to measure a specific competence or skill. Answering one question means that the learner knows one fact, and the responses to all questions must be analyzed to reach a conclusion about what learners are likely to know and what they do not know in general ⁽¹¹⁾ .

Game-based Assessment for Students at a Certain Stage

It is vital, before designing a game-based assessment, to be aware of the principles and foundations of game assessment; in games, players interact with the surrounding environment and the values of different game variables change. For example, being exposed to an injury while playing weakens your strength, which may mean gathering supplies to increase your energy and compensate for what you lost to achieve a specific reward or rank. However, other variables appear in the games, in addition to ensuring the health status, such as teamwork skills, creative and logical thinking, or when any of these variables decrease, the player can enhance them and increase their level. It is clear that effective game design enhances learning; many researchers have claimed that a lot of learning and development of these games takes place annually. However, what exactly can be learned from the game? Do these skills that learners gain while playing have educational value? One of the challenges that teachers who want to use game-based assessment may face is drawing valid conclusions, determining what learners know, do, and believe, as well as what they can learn and share. Therefore, using an evidence-based design approach is one of the solutions to deal with this challenge, where the use of this approach enables an estimate of students' competency levels and provides further

evidence to support claims surrounding these competencies. Furthermore, by using this approach, teachers can measure what learners obtain from their interactions with games and link them to an accurate assessment of lower-order thinking skills, such as knowledge, understanding, and application, as well as higher-order thinking skills, such as creating logical thinking, critical thinking, analysis, synthesis, and evaluation ⁽¹¹⁾ .

Video games may cultivate creativity; a game designer Wright (2006) describes video games as dream machines that have the power to unleash the human imagination. Wright also argues that a game is a possibility space because video games begin with a specific situation and end with a specific condition and goal. The way in which players reach the goal is an open-ended method; they can navigate the potential playing spaces and make appropriate choices and decisions to reach the goal ⁽¹²⁾ . Gee (2005) makes similar claims about the possibility of a well-designed game supporting learning principles and learners' creativity as players are not only consumers, but also producers that make appropriate choices and actions while playing; what they do to advance through levels is a form of production ⁽¹³⁾ . Furthermore, good games often encourage players to try, discover new things, take risks and learn from mistakes and failures; failing is an ideal way to receive immediate feedback to progress and is not considered as negative as in a traditional assessment. There are also some tasks in the advanced levels in the game that may pose a challenge to players; this difficulty gives the players a sense of achievement and pride when completing a task ⁽¹⁴⁾ .

Validity of Game-based Assessment in Educational Institutes

In recent years, game-based assessment has received significant attention from gaming and education research, and many educational institutions have begun to use it instead of traditional tests, which often create anxiety, tension, and fear among students during exams. Several studies have investigated

the application of game-based assessment in schools and universities. One study used three-dimensional computer games to measure the effect of using this type of games on student's tension during the test; the sample in this study included higher education students, who were evaluated with traditional and game-based assessments in a 2 x 2 cross-over design. This approach was applied to 30 postgraduate students (14 males and 16 females) aged from 23 to 45 who attended a course called Multimedia System. In this study, the researchers aimed to investigate the effect of using an educational game as a method for assessing students' performance in the exam compared to the traditional test method, in addition to determining the effect of this type of assessment on students' test anxiety and whether there was a relationship between students' anxiety about the test and their performance in an exam. The participants of the study were examined using a 3D game and online test, where the study compared the effectiveness of the different types of assessment. The first part of the study followed a game approach, whereas the second did not. However, the two parts were identical in terms of the educational material, and the participants used the two methods in successive periods of time. Before implementing the research methods, the participants filled out online biographical data questionnaires related to age, computer use, video games, and game-based assessment as the students were postgraduate students from diverse backgrounds, such as computer and educational studies. Student anxiety was tested for both assessment methods with a bio-feedback device. This device collected physical and vital signals based on skin temperature and heart rate to indicate levels of anxiety among students. After completing the experiment, an interview was conducted with students to investigate their opinions and preferences between the two methods. In addition, students were asked about their feelings of anxiety during the two assessment methods to determine if their answers matched the results recorded by the bio feedback device. The game was a three-dimensional treasure hunt game, and its story was of a group of scientists trying to find valuable

items. The goal of the game was for players to discover objects that have multiple choices questions hidden in the virtual world; the learners would have to answer these questions correctly before time runs out based on the knowledge that each type of object has a specific role in the execution of the game. The statistical results suggest that students' anxiety decreased when they used the game as an assessment method, unlike when using the traditional exam method, as the students did not feel that they were being evaluated when playing the game, which helped them reduce the level of anxiety or not cause anxiety in the first place. In terms of exam performance, the results suggest that students' performance was significantly higher when using game-based assessment than when taking a web-based test ⁽¹⁵⁾ .

In addition to improving students' performance when using game-based assessment, a recent study (Hautala et al., 2020) investigated, in terms of results and statistical analyses, the effectiveness of using game-based assessment in determining reading difficulty among primary school students. The sample in this study included 741 first- to fourth-grade students (aged 6 to 11 years, 327 males, 401 females), and the game-based assessment was implemented using tablets under supervision. In this study, different types of tasks and scales were used to assess basic reading skills to detect troubled readers: word reading; pseudoword reading; sentence reading comprehension; word spelling; and pseudoword spelling. For example, in a sentence reading comprehension task, the student in the game was asked to read a sentence as quickly as possible and determine whether the written sentence was true or false. On the other hand, in the word reading task, students were asked to read the single-syllable and multi-syllable words aloud quickly and accurately within two minutes. For word spelling skills, the task involved spelling the words presented through an audio track and repeating each of the 20 words once. Once the student had completed the set of assessment tasks, he/she was directed to continue the other educational games until completing all tasks on the device. The

descriptive analysis found that troubled readers differed from normal readers in measures of fluency and accuracy in all assessment tasks, and that GBA tasks worked fairly and encouragingly to identify reading difficulties. This study found that reading difficulties for primary school students, which are traditionally determined by assessing reading skills that is administered individually in the form of paper and pencil, may be reliably identified with game-based assessment tasks ⁽¹⁶⁾ .

A number of other studies have examined the relationship between game-based assessment and students' higher-order thinking skills, such as problem-solving skills, critical thinking, and creativity. Shute, Moore, and Wang (2015) used stealth assessment as an approach that employed games to evaluate students to measure problem-solving skills among middle school students using a video game (Plants vs. Zombies) via Bayesian networks. This game challenged participants collect plants and arrange them in a certain way to defeat all zombies over all stages of the game. The results found the positive use of stealth assessments when playing this game, but there was a limitation in terms of sample size, in that it was small ⁽¹⁷⁾ .

Highlighting the importance of problem-solving skills, Shute and Wang (2015) verified the effectiveness of using video games (Portal 2) to assess and eventually support problem-solving skills in high school students. Although there were some limitations in this study, such as “potential sources of error variance in video game assessments such as the level of interest in the target game” (Shute and Wang, 2015, p. 18). The researchers found that the video game Portal 2 could be used to assess problem-solving skills as it was more realistic and attractive in terms of tasks than traditional assessment ⁽¹⁸⁾ .

Hwang, Hung, and Chen (2014) followed the same approach as the previous studies in terms of evaluating problem-solving skills and evaluating student achievement and motivation. However, study was conducted on 167 sixth-grade students divided into two groups. The first group was the experimental

group that consisted of 82 students assigned to the peer game-based assessment development approach, while 85 students were in the control group and assessed with a traditional game development approach. The results suggest that the proposed approach depends on peer game-based assessment and whether it could successfully promote students' learning achievement, motivation, and problem-solving skills. Another advantage that students found from using game-based assessment in this study was that they realized this effective evaluation method helped them to improve their learning status in terms of creativity, deep thinking, and motivation. Similar to existing research, this study contained limitations in terms of ignoring some of the educational and interactive patterns. Furthermore, students' performance and innovation were not counted in this study. Finally, "personal factors that may be relevant to individuals' cognitive levels, learning habits, or cognitive processes were not measured and analyzed" (Hwang, Hung, and Chen, 2014, P. 142) ⁽¹⁹⁾.

In a group of younger children, Tsegai, Fisher, and Eng (2021) tested whether game-based cognitive assessment alleviated the challenge of cognitive assessment for children aged 3-5 due to children's low attention span and the tiresome nature of cognitive assessments. The flanker task used in this game asked the 21 participants to suppress attention to distractions and to focus narrowly on the stimulus goal. Participants were asked to press a button corresponding to the direction of the central target arrow surrounded by terminal arrows. As the children played, they listened to a narrative to help Frank the center fish collect the treasures from the ocean. Whenever the fish went in the right direction and gets the treasure, the children would receive a reward, namely the ocean treasure in a jar as a positive comment. Thus, this game allowed the participants to see their progress, as well as the number of ocean treasures that they collected in the jar. In this study, performance in the game-based assessment was significantly associated with performance in a traditional measure of mathematical and verbal test results, cognitive control, and

functional brain connectivity. The results and statistical analyses suggest that there is a stronger preference and higher levels of enjoyment comparing game-based assessment to traditional cognitive control assessment ⁽²⁰⁾ .

Conclusion

This paper reviewed the game-based assessment foundations and some of its previous and current applications in educational institutions for different educational stages. This type of evaluation has a clear positive impact; studies have demonstrated its effectiveness in enhancing students' performance and higher order thinking skills, in addition to other valuable skills and alleviating stress and anxiety during exams. This approach may be widely used in the future considering all the obstacles and limitation in the previous studies where researchers can improve predictive indicators based on existing games for evaluation or design new games according to the purpose of the study. Assessment of serious game-based learning experiences should also reflect various features such as game type, educational objective, or game context to design high-quality, more valid, and reliable educational games. There is also a suggestion that could help in the development of this approach, which is to make a comparative study between two different stages of studies, such as middle and high school, and they share the same educational goals and materials, then they will be evaluated based on the educational game that specifically designed for both grades. According to previous studies, this game can help students to improve their educational performance, and the results and statistics from new studies will benefit subsequent studies in filling the gaps.

References

1. Bushlalaq N. **Electronic Educational Game-based learning**. *Journal of the Association of Arab Universities for Research in Higher Education*. 2019;39(1):18.
2. Triantafyllakos G, Palaigeorgiou G, Tsoukalas IA. Designing educational software with students through collaborative design

- games: The We! Design&Play framework. *Computers & Education*. 2011;56(1):227-42.
3. Papastergiou M. Digital game-based learning in high school computer science education: Impact on educational effectiveness and student motivation. *Computers & education*. 2009;52(1):1-12.
 4. Al-Qarni Z, Qarn A. *Education Technology Theories and its Educational Applications*. First ed. Jeddah: Tkween Combination; 2021.
 5. Carvalho MB, Bellotti F, Berta R, De Gloria A, Sedano CI, Hauge JB, et al. An activity theory-based model for serious games analysis and conceptual design. *Computers & education*. 2015;87:166-81.
 6. Arieli-Attali M, Ward S, Thomas J, Deonovic B, Von Davier AA. The expanded evidence-centered design (e-ECD) for learning and assessment systems: A framework for incorporating learning goals and processes within assessment design. *Frontiers in psychology*. 2019;10:853.
 7. Serrano-Laguna Á, Manero B, Freire M, Fernández-Manjón B. A methodology for assessing the effectiveness of serious games and for inferring player learning outcomes. *Multimedia Tools and applications*. 2018;77(2):2849-71.
 8. Ifenthaler D, Eseryel D, Ge X. *Assessment for game-based learning*. *Assessment in game-based learning*: Springer; 2012. p. 1-8.
 9. Smits J, Charlier N, editors. *Game-based assessment and the effect on test anxiety: A case study*. *European Conference on Games Based Learning*; 2011: Academic Conferences International Limited.
 10. Ruliany S, Purnawarman P. *Teacher's Perception of Mobile Game-Based Assessment in ELT Context*. 2021.
 11. Shute VJ. Stealth assessment in computer-based games to support learning. *Computer games and instruction*. 2011;55(2):503-24.
 12. Wright W. Dream machines. *Wired Magazine*. 2006;14(4):110-2.
 13. Gee JP. Learning by design: Good video games as learning machines. *E-learning and Digital Media*. 2005;2(1):5-16.
 14. Shute VJ, Rahimi S. Stealth assessment of creativity in a physics video game. *Computers in Human Behavior*. 2021;116:106647.
 15. Mavridis A, Tsiatsos T. Game-based assessment: Investigating the impact on test anxiety and exam performance. *Journal of Computer Assisted Learning*. 2017;33(2):137-50.
 16. Hautala J, Heikkilä R, Nieminen L, Rantanen V, Latvala J-M, Richardson U. Identification of reading difficulties by a digital game-based assessment technology. *Journal of Educational Computing Research*. 2020;58(5):1003-28.

17. Shute VJ, Moore GR, Wang L. Measuring Problem Solving Skills in Plants vs. Zombies 2. International Educational Data Mining Society. 2015.
18. Shute VJ, Wang L. Measuring problem solving skills in Portal 2. E-learning systems, environments and approaches: Springer; 2015. p. 11-24.
19. Hwang G-J, Hung C-M, Chen N-S. Improving learning achievements, motivations and problem-solving skills through a peer assessment-based game development approach. Educational technology research and development. 2014;62(2):129-45.
20. Tsegai-Moore AS, Fisher A, Eng CM, editors. The Construct and Criterion Validity of a Cognitive Game-based Assessment: Cognitive Control, Academic Achievement, and Prefrontal Cortex Connectivity. Proceedings of the Annual Meeting of the Cognitive Science Society; 2021.