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How to Develop a Memory Game for Clinical Courses: A Leading Approach to the Interaction of Education

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Abstract

The integration of educational games has significantly transformed pedagogical approaches, emphasizing the importance of constantly updating educational programs. High-quality games motivate students and foster engagement, surpassing traditional methods. Addressing this need, this protocol study aimed to provide practical instruction on developing a memory game. Educational memory games have been found to enhance intrinsic motivation in learners and are particularly beneficial for clinical subjects. The design of memory games involves three components: Pedagogical level, design level, and modeling of learning content. Adjusting elements, such as the number and nature of items, time limits, feedback mechanisms, and task difficulty, can fine-tune the effectiveness of a memory game. The memory game consists of 2 main components: Learning and scoring, and it is designed using Articulate Storyline software. The learning phase focuses on mastering correct methods; however, the scoring phase evaluates learning retention and comprehension. Memory games can be adapted to different formats supported by educational websites and learning management systems. They are an effective tool for enhancing cognitive development and memory retention; however, it is important to consider the audience's age, learning goals, genre, and assessment approaches when determining the ideal content level. Memory games can be used to identify learning challenges, promote active student engagement and collaboration, and improve learning outcomes. Educators must continually evolve their methods to resonate with new generations of learners, and success in implementing memory games depends on considering lesson characteristics, student needs, and instructor expertise.

Keywords: Game, Education, Learning, Develop, Students, Clinical

1. Background

The current generation of students, often labeled as digital natives, is deeply ingrained in technology. They heavily rely on electronic tools to enrich their learning and acquire knowledge in a dynamic and interactive manner (1). Unfortunately, traditional educational methods are struggling to meet the distinct needs and preferences of these tech-savvy learners (2). To ensure that education remains relevant and effective in the 21st century, it is crucial for universities to adapt and embrace the potential offered by evolving technologies (3). This entails integrating digital platforms, such as interactive games (4-6), virtual simulators (7), wearable tech devices (8), or social media channels, into classroom teaching. By doing so, educators can harness students' intrinsic motivation derived from their familiarity with technology (2). Neglecting the imperative need for technological integration in education could lead to a diminishing appeal of traditional educational systems (9). It is evident that present-day students greatly benefit from interactive digital resources that are tailored to their unique learning methods. Therefore, formal education institutions must not only acknowledge but also harness the potential offered by progressive technologies if they aspire to deliver genuinely effective learning experiences for upcoming generations (10).

The educational games of the last decades have changed the pedagogical approaches (11). On the other hand, the increasing growth of knowledge cannot be

adequately accommodated within the framework of old education, and a change in educational programs is urgently needed (12). A lack of educational programs that interact with students will be strongly felt in the future due to the shift in learning generations (13). Several studies have examined the relationship between educational games and intrinsic motivation (5, 6, 14, 15). Park reported that learners who actively engaged with these games exhibited higher levels of intrinsic motivation (16). Similarly, Yu et al. researched game-based learning and discovered a range of effects on motivation, some positive and others negative (17). While acknowledging skepticism toward serious games in formal learning environments, Passarelli also recognized their potential to enhance learning outcomes (18).

Additionally, Felicia's work from 2011 offered theoretical frameworks and empirical evidence supporting the notion that video games can contribute to students' overall motivation to learn; however, it underscored the importance of effective game design and teaching strategies for optimal results (19). The most crucial factor that has not been addressed in many studies is the quality of the games, how games can be used to motivate learners, and the extent to which this can be done. In addition, interactive training has had a negative impact on many interventions that are of low quality in terms of content (20). Therefore, developing an educational game that engages students in learning is essential.

One learning game that can promote student engagement is memory games. These games aim to reduce the cognitive load of memory due to the negative effects of memory. The goal of these games is for students to learn to memorize learning material more easily through trial and error. Several studies have shown that these learners' decisions and feedback lead to learning because they decide what they want to do and try to learn the correct way when they make a mistake (20, 21). Because learners participate in the lesson themselves, they are not judged by teachers or other students when they make a wrong decision, and their self-esteem remains high. Repetition is vital for students (6, 22). This study offers a comprehensive exploration of the process of developing a memory game, delving deeply into its practical aspects. The focus of these games is mainly on clinical subjects, such as anatomy, biochemistry, physiology, medicine, and anesthesiology. The authorship of this protocol article can be attributed to a PhD student specializing in e-learning within the medical sciences domain and the expertise in creating and managing educational games. The introduction is visually presented in a file accessible via the following link: https://bit.ly/47RYczi.

2. Methods

The software used to design this type of game spans the likes of Articulate Storyline, Adobe Captivate, and Lectora. In this study, the focus is on imparting design skills centered around the widely popular Articulate Storyline software.

2.1. Educational Design of the Memory Game

The educational design of this type of game is thoroughly documented in the recently published article in BMC Medical Education journal (4). In developing this game, we carefully considered three crucial components: The pedagogical level, which addresses how educational content is presented and learned; the design level, encompassing the visual and interactive elements of the game; and the modeling of learning content, focusing on how educational concepts are integrated into gameplay to enhance understanding. Motivational theories draw upon a wide range of motives, including intrinsic factors like pleasure, curiosity, and interest, alongside extrinsic factors such as rewards or punishments (23). When designing the game interface, principles from behaviorism, such as trial and error and scoring, are implemented to shape user engagement (24). Based on the constructivist theory, game components face the challenge of identifying and addressing related issues within the game and understanding how they are interconnected (25). This process helps establish a clear position for each game element. Additionally, drawing from cognitivism, self-directed learning is also integrated into this approach to further enhance the overall experience (26). The different levels of game design encompass a wide array of elements such as educational objectives, curriculum alignment, usability, user satisfaction, and leveraging prior knowledge. When designing learning materials for games, careful consideration should be given to aligning the content with the appropriate curriculum objectives, providing scaffolding support for learners, and ensuring that the content matches their needs and abilities.

3. Results

3.1. Pedagogical Level

Memory games are a valuable form of cognitive training that stimulates the brain by challenging participants to recall or match items based on various factors. These activities can serve an educational purpose and be tailored to accommodate different levels of learning. Experts often use Bloom's taxonomy of cognitive domains, which includes 6 levels, namely knowledge,

comprehension, application, analysis, synthesis, and evaluation, to categorize the pedagogical level at which a memory game operates. Each level requires increasingly advanced cognitive processing and complexity in problem-solving. The effectiveness of a memory game can be fine-tuned by adjusting elements, such as the number and nature of items involved, time limits for responses paired with feedback mechanisms for reinforcement, and through managing task difficulty while ensuring variability in challenges presented; these, along with introducing varying degrees foster interaction among players, all contributing significantly to modifying its pedagogical impact. Selecting an appropriate pedagogical level is crucial as it directly impacts both learners' engagement and their outcomes, essentially enhancing motivation toward learning.

When designing an educational model for a memory game, it is essential to carefully consider the learning objectives. These objectives should reflect specific skills or knowledge that the game aims to foster or assess. For instance, the game could target visual memory, auditory memory, spatial memory, working memory, long-term memory, or semantic memory. Moreover, these learning objectives should align with curriculum standards and cater to the needs and interests of the learners. Furthermore, it is crucial to delve into the intricacies of game mechanics by identifying how they function and understanding the rules and actions available to players. This might include elements such as timers, score systems' feedback mechanisms, difficulty levels, hint systems, and reward structures. All these components play a pivotal role in ensuring that the game mechanics are engaging, challenging, and motivating for its intended audience.

When considering game content, it is important to ensure that the items used are closely linked to the subject matter and presented in a way that resonates with learners. This entails using words, images, sounds, or symbols that authentically represent concepts and terms from the subject domain while being suitable for the learners' level and background. In evaluating games, it is essential to measure their impact rigorously. The effectiveness of the game could be assessed through methodologies, such as pre-tests and post-tests, surveys, interviews, observations, or analytics. It is vital that these evaluation methods provide valid, reliable data on aspects such as learner performance, behavior patterns, and attitudes toward learning processes within various contexts. All evaluations should adhere strictly to ethical considerations.

3.2. Design Level

The memory game is composed of two main components: Learning and scoring, both meticulously designed using the Articulate Storyline electronic content creation software (4). The learning phase focuses on mastering the correct method; however, the scoring phase involves points being awarded and feedback given. Once individuals have successfully grasped the learning component, they progress to the assessment part, where their choices directly reflect what they have learned with no room for trial and error. The design level is visually presented in a file accessible via the following link: https://bit.ly/3GmHYT4.

3.2.1. Learning Section

The focus of this section is purposeful learning. Here, students delve into understanding how the placement of game components aligns with theories, such as behaviorism, motivation, and constructivism, to form a key part of the learning content. Designing this section involves following specific steps that integrate these theories in meaningful ways:

- First, select a schematic representation of the course (e.g., pictures of a basic science course) and then delete or blank out the sections you want students to learn (this process can be done using design tools such as Paint).

- After removing the sections you want from your photo, enter them into Storyline and replace the important sections with blank boxes.

- Create a box on the slide and enter the correct sentence. Repeat this process for each blank box you created on the page.

- Then, go to the filled boxes and select the option to create a new state on the page. Then, create both Show and Correct modes in this status.

- Change the color of a box in the show section to the color you want and switch the color of a box in the correct section to green; do this for each box that contains text, and then select a function from the trigger section for each box. A detailed description of the procedures showcasing various elements and their interactions is illustrated in the following link: https://bit.ly/3GmHYT4.

Each box that contains text is indicated with the following 2 functions:

3.2.1.1. Trigger

This function changes the mode when the mouse pointer hovers over the desired area. In game design, this function serves a primarily aesthetic purpose and adds to the overall visual appeal of the game. To create this function, start by clicking on the text box and then select the "Trigger" option from the menu on the left (represented by an X). Once you are directed to a newly opened page, make sure to implement these specific changes as follows:

In the "Action" section, choose the "Change state of" option. Then, carefully select the specific text in the "On object" field and set it to display mode in the "To state" field. Next, click on the desired text in the "Object" field and specify that you want this change to occur when someone hovers over by selecting the "Mouse over" option from the "When" dropdown menu before confirming with OK. This setup signals to the software that each time a user hovers their mouse pointer over a text box, its color will change as per your selection.

3.2.1.2. Mode Switching Function to Correct If the Box is in the Correct Position

The process of designing this mode is fundamental to the overall development of a memory game. It requires precision and attention to detail to create an engaging and interactive experience for the players. To begin, click on the box containing the desired text and navigate to the Trigger option located on the left-hand side. Here, make specific changes within the page that opens up, ensuring that each alteration enhances both functionality and user enjoyment.

On this page: In the Action section, you will need to carefully consider the State of the Object before proceeding. Make sure to select from a range of available States and then check off the appropriate box under Object. Next, choose "Object dropped on" under When and proceed by selecting an empty field containing text that aligns with your intent for dropping. Be mindful that once you select this field, any movement away from its main area will result in the text box reverting to its original position. It is important to note that until placed back in the main field, the text will not return to its correct State as intended. This dynamic might lead students to make errors while attempting their selections; however, these very mistakes can contribute significantly to their learning process. This approach should be consistently applied when dealing with boxes containing text throughout all related slides featuring anatomical or biochemical processes, among others.

3.2.2. Designing an Interactive Learning Assessment

This assessment section aims to delve into the depth of learning retention and comprehension. It strives to evaluate not only if learning has occurred but also its extent and effectiveness. By communicating clear expectations in this section, learners can be instructed that a reattempt of the game is required in cases where the specified score (e.g., 70% or more of the possible points) is not achieved.

In this section, the design incorporates a unique approach to learning where learners are encouraged to make mistakes and can earn points by placing them in the correct location. The process involves copying and pasting slides from the learning section into this segment. By unchecking all boxes on the left, users can switch to Show mode. Moving on to the state section, they need to align the correct State with its respective color box from the original or primary set, allowing for flexibility without fixing box colors when placed correctly. Additionally, users should navigate to Variables on the left side of the page and create a new numeric variable with an initial value of zero. To complement this setup, creating a function in Trigger for specific text boxes is also essential for effective functionality.

3.2.2.1. How to Design the Scoring Section and Assessment

This section of the assessment is intended to gauge the level of learning that has taken place through memory processing in the brain. Its primary focus is on assessing how effective the learning process has been. In designing this section, we incorporated slides from the learning module. However, learners are permitted to make errors, and if they correctly position them, they can earn allocated points. To accomplish this:

- Copy and paste the slides from the learning section into this section, ensuring that all relevant information and graphics are included to enhance understanding.

- Remove all checks from the boxes on the left, transitioning to Show mode for a more interactive presentation experience.

- Navigate to the state section and adjust the state color to match that of the original or primary box.

This will ensure that the box retains its original color and does not become fixed upon placement in the correct position. To start, navigate to the left side of the page, click on "Variables", and then proceed to create a new variable by selecting a numeric option from the available choices and setting its initial value to zero. Next, go back to the slide page, click on the text-containing box once more, and proceed to create the specified function within the Trigger section:

In the action section, choose the adjust variable option and then select the previously created variable. In the operator section, choose the add option, and in the value section, select number one as your value. Under "When", choose State. Then, select any of the "On" options and check all boxes containing the specific text below. Lastly, choose "Are followed by Correct" in two rectangular boxes without selecting any slide components. When dragging a desired shape into specified sections, the second function adds zero points to the selected variable. The process can be summarized as follows:

- Select the Adjust Variable option from the Action position and choose the specific variable you created.

- In the Operator section, set it to "Add" with a value of 0. Set the when section to "Object Dragged Over" and then add a new "Object" section.

- Within this added section, select the desired shape, and in "Hover Over", select the empty boxes (rectangles) on your slide for each area.

This command allows the placement of shapes on any field; however, points are only earned when in the main position.

3.2.3. Commands for Displaying the Scored Points

Once you have finalized the scoring method and assigned functions to all shapes, it is essential to reference the variables on a new slide page. To achieve this, create an object like a shape or text box, and from the Insert menu, select References. Then, choose the numeric variable you have created on the subsequent page.

3.3. Preserved Edition

Game publishers often adhere to the standard formats supported by Storyline 3 software. For integration into an educational website, opting for web output in HTML5 format is advisable. Meanwhile, embedding the game in a learning management system calls for the use of Scorm compliance to ensure seamless interaction and functionality within the platform.

3.4. Content Level

A memory game serves as a widely embraced educational tool, fostering cognitive development and the retention of memories. When crafting a memory game for an academic setting, it is crucial to delve into the intricacies of determining the ideal content level. This encompasses ensuring that the game is engaging and challenging for its intended audience and considering how to cater to diverse cognitive abilities and prior knowledge levels among players. The task involves striking a delicate balance-ensuring that players at varying proficiency levels can participate while still receiving valuable learning opportunities from the experience.

When determining the content level for a memory game, it is crucial to consider the intended audience's age and the game's educational objectives. Younger children might benefit from more straightforward content, such as matching pairs of objects or identifying colors; nevertheless, older children and students might require more intricate challenges, such as matching words to pictures or solving puzzles. Moreover, it is essential that the content level aligns with the learning goals of the education model. For instance, if enhancing vocabulary skills is one of these goals, then including relevant subject matter-specific words would be advantageous. Similarly, incorporating mathematical operations and related problems at an appropriate difficulty level becomes paramount when aiming to improve math concepts through gameplay.

Finding the right balance in creating a memory game is crucial – one that is not too easy or too hard. If the content level is set too low, it might not captivate players, as there will not be enough challenges. Conversely, players could become frustrated and lose interest if the content level is overly high. To pinpoint the appropriate content level, conducting initial assessments or seeking advice from educators and educational experts can provide valuable insights. This information proves instrumental in shaping the game's development and guaranteeing an optimal difficulty level for its intended audience. Therefore, it is crucial to take into account a range of factors when developing the content level and game model for an educational game. These factors include the audience being targeted, learning goals, genre of the game, and assessment approaches.

4. Discussion

Teaching can be enhanced by incorporating memory games, especially when traditional educational methods are not feasible or time-efficient. These games offer educators a valuable tool to pinpoint students' learning challenges and tailor their instruction accordingly. The most favorable learning outcomes often result from active student engagement, making the interactive nature of these games particularly impactful as it aligns with motivational theories and encourages collaboration (4, 5, 15, 27). Furthermore, drawing insights from behavioral theories reveals that students are incentivized to excel through competition by recognizing their strengths and contributions within the educational context (28). Additionally, it is worth noting that comprehensive performance data from these games can also be meticulously recorded for further analysis and evaluation beyond the scope of this article.

This game offers a tangible and straightforward training program for teachers to incorporate into their lessons quickly. It provides an interactive approach that allows interested teachers to easily modify the game, incorporating additional features, such as audio or video tutorials (29). The potential impact of teachers' creativity on the success of memory games is emphasized, highlighting its crucial role in teaching

memory games (4). The goal of this game is to shift away from traditional paper printouts of instructional pathways and introduce a more engaging, game-based approach (4). This new method recognizes the importance of memory in retaining medical information and addresses the challenges patients face when recalling such data (4-6). Research by Kessels emphasizes the significance of memory in retaining medical information and highlights difficulties patients encounter when retrieving such data (30). Another study by Bochennek et al. explores how card and board games can serve as effective educational aids in medicine, offering promise for improving learning outcomes (31). Longge's study in 2011 delves into the effectiveness of a tailored graphic memory game developed for medical students, shedding light on its positive influence on knowledge acquisition within this population. The study emphasizes not only the entertainment and sociability aspects but also how games can reach further to support learning in line with the specific needs and psychological development levels of the students (32).

In today's digital age, the pervasive use of smartphones and other electronic devices has drastically altered the way students engage with learning. As a result, educators must continually evolve their pedagogical methods to resonate with each new generation of learners effectively (33). Neglecting this necessary evolution could lead to students feeling increasingly disconnected from their academic environments. It is imperative for teachers to design educational games that align with both their instructional goals and the technological capabilities at hand. The challenge arises when lessons fail to integrate these elements seamlessly, leading initially enthusiastic students into a state of diminishing motivation and an inclination toward passive consumption of theoretical content over active engagement. Therefore, it becomes evident that success in implementing such gaming approaches hinges on considering key factors, such as the specific characteristics of the lesson itself, understanding the unique needs of student audiences, and leveraging instructors' adeptness in navigating this dynamic landscape.

4.1. Conclusions

Memory games have the potential to significantly enhance teaching by providing valuable insights into individual learning difficulties and facilitating active engagement. The motivational and collaborative nature of these games fosters healthy competition based on personal advantages and values, ultimately contributing to improved learning outcomes.

Footnotes

Authors' Contribution: M.M.H. was responsible for the study's conception and design and supervised the study's content design. S.T.M.H., K.Q., and Sh.H. critically reviewed the article.

Conflict of Interests: The authors have no conflict of interest regarding the content of the article. However, there is a family relationship between the first and second authors. The first author designed the game, while the second author was responsible for its educational design, which speaks to their collaborative effort in producing this work.

Data Availability: Upon a reasonable request, the corresponding author can provide the movie set created for the game.

Ethical Approval: This study aims to provide a comprehensive guide for creating and developing an educational game, based on the literature review and the authors' experience. Since this study does not involve any human subjects or data collection, there is no need to apply the code of ethics for this study.

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