EAI Endorsed Transactions
on Context-aware Systems and Applications
Research Article EAI.EU

Creative Brain Training Apps and Games Can Help Improve Memory, Cognitive Abilities, and Promote Good Mental Health for The Elderly

Nattanun Siricharoen[1*]

[1] Faculty of Communication Arts, Huachiew Chalermprakiet University, Thailand

Abstract

This qualitative research study aims to explore the effectiveness of creative brain training apps and games in enhancing memory, cognitive abilities, and promoting good mental health among the elderly. The research is based on feedback and experiences provided by a second-year university student who has close relationships with elderly individuals. Data will be collected between June and July 2023. The informant's firsthand experiences and insights will be utilized to evaluate games and applications specifically designed to strengthen memory, thinking, analysis, brain exercises, eyesight, and other cognitive functions. By investigating the impact of these interventions, this study aims to contribute valuable information to enhance the mental well-being and cognitive capabilities of the elderly population.

Keywords: Elderly, Thinking, analysis, Cognitive abilities, Mental health, Brain training apps, Brain exercises

Received on 03 July 2023, accepted on 25 July 2023, published on 28 July 2023

doi: 10.4108/eetcasa.v9i1.3524

* Corresponding author. Email: nattanun2004@yahoo.com

1. Introduction

The development of digital technology has brought about significant benefits for the elderly population, improving their overall well-being and quality of life. One of the most noticeable advantages is the positive impact on communication. Smartphones and tablets have become user-friendly devices that enable older adults to stay connected with their loved ones through various applications for communication, entertainment, online services, and even healthcare [1]. With the help of video calls, social media platforms, and messaging apps, older adults can bridge the gap of distance and maintain meaningful connections with their families and friends. This connectivity plays a crucial role in combating social isolation and loneliness, which are common challenges faced by many elderly individuals.

In addition to communication, digital technology has also revolutionized health and wellness for the elderly. Wearable devices such as smartwatches and fitness trackers have gained popularity in monitoring vital signs, physical activity, and providing medication or appointment reminders. These devices empower older adults to take an active role in managing their health, allowing them to track their progress, identify potential health issues, and make informed decisions about their well-being. Moreover, telehealth services and remote monitoring platforms have emerged as valuable resources, enabling older adults to have remote consultations with healthcare professionals and receive timely interventions. This convenient access to healthcare not only reduces the need for frequent travel but also ensures that seniors can receive necessary medical attention from the comfort of their own homes [2].

Digital technology has also introduced voice-activated assistants such as Amazon Echo or Google Home, which

have proven to be beneficial for the elderly population. These devices provide hands-free assistance, allowing seniors to perform tasks, set reminders, make calls, and even control various smart home devices simply by using their voice. Such technology promotes independence, convenience, and accessibility, particularly for those with mobility or dexterity limitations. Furthermore, smart home technology has improved safety and security for older adults. Home automation systems with voice-activated features enable lighting control, temperature regulation, security monitoring, and overall convenience, enhancing the comfort and peace of mind for seniors.

Managing medications can be a complex task for many elderly individuals, but digital technology has offered solutions in the form of medication management apps. These apps help older adults organize, track, and remind them about their medications. Some even provide features for prescription refills and caregiver monitoring, ensuring that seniors stay on top of their medication routines and avoid potential complications. Moreover, social media platforms and video calling applications such as Facebook, WhatsApp, and Skype have become essential tools for older adults to stay socially connected. These platforms enable seniors to interact with family and friends, share experiences, and participate in online communities, thus reducing feelings of isolation and improving their overall mental well-being [3].

Safety and emergency response systems have also greatly benefited from digital technology advancements. Personal emergency response systems and wearable buttons allow older adults to call for help in case of emergencies, connecting them to 24/7 monitoring centres that can dispatch assistance when needed. These systems provide a sense of security and reassurance, enabling older adults to maintain their independence while knowing that help is readily available when required.

While the benefits of digital technology for the elderly are evident, it is crucial to address the potential safety and security concerns that may arise. Older adults may be more vulnerable to online scams, privacy breaches, and other digital threats [4]. Therefore, it is essential to provide them with education on safe internet practices and empower them with the necessary knowledge to protect their digital privacy and security. Caregivers and family members play a significant role in supporting older adults in navigating the digital world safely, providing guidance, and offering assistance.

Furthermore, cognitive training apps have emerged as valuable tools for older adults. These brain-training apps and games are designed to improve memory, cognitive abilities, and mental well-being [5]. They offer engaging exercises and challenges that help older adults maintain and enhance their cognitive skills, promoting brain health and overall cognitive function.

2. Review of the Literature

Creative brain training apps and games can be used to improve memory, cognitive abilities, and promote good mental health among the elderly [6]. These applications and games offer engaging activities specifically designed to stimulate various cognitive functions, including memory, attention, problem-solving, and critical thinking. Regular engagement with these activities can enhance mental agility and overall well-being in older adults such as:

Memory games, [7] such as matching cards or sequence recall games, are tailored to enhance memory and cognitive abilities by providing a stimulating environment. These games require players to remember and recall information, thus engaging their short-term memory. By repeatedly playing these games, individuals can improve their memory retention and overall attention span. The act of concentrating on the game and actively searching for matching cards or recalling sequences helps strengthen neural connections related to memory. As a result, regular practice of memory games can lead to significant improvements in cognitive function and mental agility.

Lumosity [8] has been used by millions of people worldwide and has received both positive and critical reviews. Lumosity's "Memory Match Overdrive" is a popular game offered by the platform to enhance players' memory skills. It involves matching pairs of cards by remembering their locations within a grid. Lumosity also offers a diverse range of other games and exercises targeting various cognitive abilities, such as attention, math, word recall, and problem-solving. The program tracks individual performance and provides personalized feedback and training sessions. However, the effectiveness of brain-training programs like Lumosity is still a topic of debate in the scientific community. It is crucial for individuals to consider their goals, commitment to regular training, and overall cognitive health when evaluating the efficacy of these programs. Consulting healthcare professionals or cognitive training experts can provide valuable guidance in determining the best approach for improving cognitive skills based on individual circumstances.

Elevate is a mobile application [9] that aims to improve cognitive skills such as memory, math, reading comprehension, and speaking abilities. Upon downloading the app, users are prompted to create an account and complete an initial assessment. This assessment evaluates their cognitive abilities in various areas and helps identify their strengths and weaknesses.

One of the key features of Elevate is its gamified approach. The exercises and games are designed to be engaging and interactive, making the learning process enjoyable. The app also includes progress tracking, allowing users to monitor their improvement over time. Additionally, Elevate incorporates motivational features such as reminders and rewards to encourage regular practice and maintain user engagement.

By using Elevate consistently, users can actively enhance their cognitive abilities. The app's targeted training programs help users develop their memory, math, reading comprehension, and speaking skills, which can have a positive impact on their overall cognitive performance in daily life.

Peak is a comprehensive brain training app [10] that offers a wide range of games and puzzles to enhance cognitive abilities. With a focus on memory, focus, language, and problem-solving skills, users can tailor their training sessions to specific areas of interest. The app begins by assessing the user's cognitive abilities, allowing for personalized training plans and progress tracking. Users can engage in daily challenges, maintain streaks, and receive notifications and reminders to stay consistent. With its detailed insights and curated workouts, Peak provides an effective platform for individuals looking to improve their cognitive performance. In conclusion, Peak offers a user-friendly and customizable experience for brain training. By engaging in a variety of challenging games and puzzles, users can enhance their memory, focus, language, and problem-solving skills. With features like personalized assessments, progress tracking, and daily challenges, Peak motivates individuals to stay consistent with their cognitive training. Whether it's targeting specific cognitive areas or seeking overall improvement, Peak provides a valuable resource for those looking to sharpen their mental abilities.

CogniFit is a platform that offers scientifically designed games aimed at assessing and training cognitive skills like memory, attention, and concentration. Upon signing up and completing an initial assessment, users receive a personalized training program tailored to their specific needs [11]. For example, in the memory training module, users engage in exercises that challenge their ability to recall sequences or reproduce sounds and numbers. In the attention training module, tasks are designed to improve focus and ignore distractions, such as identifying specific symbols or tracking moving objects. CogniFit tracks users' progress over time, providing detailed feedback, performance metrics, and recommendations for targeted improvement. By consistently engaging with the personalized training program, individuals can enhance their cognitive abilities and achieve long-term cognitive development. CogniFit's scientifically validated approach offers a convenient and effective means of improving memory, attention, and concentration skills.

Sudoku is a classic number-based puzzle game [12] that improves logical thinking, concentration, and problem-solving skills. It offers different levels of difficulty, allowing users to start with easier puzzles and gradually progress. Sudoku is a popular puzzle game that revolves around a 9x9 grid divided into nine 3x3 sub-grids. The objective is to fill in the empty cells with numbers from 1 to 9, ensuring that each row, column, and sub-grid contains all the digits exactly once. The game provides a partially filled grid as a starting point, and players must use logical deduction to figure out the missing numbers. With increasing levels of difficulty, Sudoku challenges players to think strategically, analyse possibilities, and make precise decisions, fostering their logical thinking, concentration, and problem-solving abilities. By starting with easier puzzles and gradually progressing, players can enhance their skills and experience the satisfaction of solving complex Sudoku grids.

Playing word games such as Scrabble, crossword puzzles, and word search is beneficial for enhancing vocabulary, language skills, and memory recall. By engaging in these games, individuals are encouraged to think critically and strategically, searching for words that fit the given criteria. This mental stimulation promotes cognitive agility and helps expand one's lexicon as players encounter unfamiliar or challenging words. Additionally, word games require players to recall and retrieve information from their memory, improving their ability to remember and retrieve words and their meanings. Overall, word games provide an enjoyable and effective way to engage with language, enhancing linguistic abilities and promoting mental engagement.

Working on jigsaw puzzles is a great way to improve visual-spatial skills as it requires manipulating and fitting puzzle pieces together. It also enhances attention to detail as one must carefully observe the shape, colour, and pattern of each piece. Solving puzzles promotes problem-solving abilities as it involves strategizing and finding the right piece placement. Additionally, engaging in this activity can provide a calming and enjoyable experience, offering mental relaxation and a break from daily stresses etc.

The concept of creating games on applications with various algorithms [13], including

Memory Matching Algorithm: Memory matching games, where players need to match pairs of cards or objects, are popular for stimulating memory. The algorithm behind these games typically involves shuffling a set of items and randomly assigning them to the game board. As the player makes selections, the algorithm checks for matches and updates the game state accordingly.

Pattern Recognition Algorithm: Games that require players to identify and recognize patterns can also be beneficial for memory stimulation. The algorithm in such games generates and presents various patterns to the player, which they need to identify or replicate. The algorithm can be designed to gradually increase the complexity of the patterns as the player progresses.

Adaptive Difficulty Algorithm: To ensure that games remain enjoyable for elderly players, an adaptive difficulty algorithm can be implemented. This algorithm monitors the player's performance and adjusts the game's difficulty level accordingly. It aims to provide an appropriate level of challenge to keep the player engaged without overwhelming them.

Randomization Algorithm: Introducing randomness into game mechanics can add an element of surprise and enjoyment. Randomization algorithms can be used to generate unpredictable game elements, such as the appearance of bonus items, enemy behavior, or level layouts. This helps in keeping the game fresh and prevents monotony.

Reinforcement Learning Algorithm: In more advanced game applications, reinforcement learning algorithms can be employed to personalize the gaming experience for individual players. These algorithms can learn and adapt based on the player's actions and preferences, tailoring the game content and challenges to suit their abilities and interests.

The selection and implementation of algorithms, playtesting, and iterative development. The specific combination and customization of algorithms will depend on the targeted audience, desired game mechanics, and the platform or technology being used for game development.

3. Research Methodology

The researchers employed data collection methods involving small group discussions in this qualitative research [14]. The aim was to create an inclusive environment where participants could collaborate and assist one another in finding answers to the research questions. The study focused on exploring ideas for developing media and various media works that cater to the needs of the elderly.

The informants for this study comprised nine individuals who were students enrolled in the Faculty of Communication Arts at Huachiew Chalermprakiet University. These students were specifically taking the course CA3553 Health Communication during the third semester of the academic year 2022. All participants were in their second year of study and possessed prior experience in utilizing digital technology and various applications on mobile phones, notebooks, and tablets.

Each participant had elderly family members, including fathers, mothers, grandparents, and others. Consequently, they possessed a practical understanding of how to effectively communicate with the elderly, ensuring the research was conducted at a practical level.

Data collection for this study took place between June and July 2023. The researchers actively engaged with the participants during this period to gather valuable insights and perspectives through small group discussions. By adopting this approach, the researchers aimed to encourage collaboration and knowledge sharing among the participants, facilitating the generation of innovative ideas for creating media that caters to the specific needs of the elderly population.

In summary, this qualitative research employed a participatory approach, utilizing small group discussions, to explore media creation and communication strategies for the elderly. The involvement of students from the Faculty of Communication Arts, who possessed both digital technology expertise and practical experience with elderly family members, provided a rich foundation for understanding and addressing the communication needs of the elderly.

4. Research Result

The research findings indicated that the majority of students expressed the belief that Thai elderly individuals could engage in gaming activities and had their own preferences. It was also observed that when children volunteered to teach and invite them to play games, the elderly participants enjoyed the experience. However, they were not particularly adept at playing games on mobile phones or other electronic devices, including personal computers. Therefore, game designs aimed at stimulating and developing their brain and memory, while providing enjoyment, should prioritize accessibility and ease of play. The games should not be overly complicated but should offer opportunities to accumulate points, borrow points, and transfer playing rights to opponents in case of difficult questions that cannot be answered or when they choose not to answer due to fear of losing accumulated points. The games should be designed to create a sense of suspense and competition, with outcomes that are determined at the last moment, whether in winning or losing. Additionally, it is crucial that the duration of the games is not excessively long or excessively difficult, as this could diminish the fun factor. This approach would encourage the elderly to find enjoyment in playing the game repeatedly or inspire them to explore other games that challenge their abilities.

The proposals for creating games for the elderly, as provided by the informants, are as follows:

Figure 1: Game Name: "Grand Game"
Source: Infomant1 (2023)

Description:
Players: The game is designed to accommodate players within three age groups:
3-10 years old
11-55 years old
55 years old or older

The intention is to allow both children and elderly individuals living in the same household to play together.
Game Rules:
3.1. Press the correct picture: Players need to select the appropriate picture as an answer.
3.2. Any picture answered is considered correct: Players can choose any picture they think is the correct answer.
3.3. Avoid searching for answers online: Players are discouraged from searching for answers on the internet to maintain fairness and engagement.
3.4. Explanation of correct answers: In case players don't understand a question, there will be an explanation provided under the picture representing the correct answer.
For example:
Question 1: Which type of food, as shown in the picture, is suitable for the elderly?
Benefits:
Explanation: The elderly should be mindful of their food and eating habits, avoiding excessive sweetness, saltiness, oiliness, alcohol consumption, and smoking. These precautions can help reduce the risk of illness and promote a healthier lifestyle as they age.

Figure 2: Game Name:
"Eagle Eye Challenge: Spot the Difference"
Source: Infomant2 (2023)

Description:
"Eagle Eye Challenge: Spot the Difference" is a captivating game that challenges your observation and concentration skills. The game presents two similar images side by side, and your objective is to spot the differences between them. Each pair of images contains five hidden variations waiting to be discovered.

Benefits:
Memory Skills: Playing "Eagle Eye Challenge" helps improve memory skills by requiring you to recall and compare details from the first image to identify variations in the second image.
Concentration: The game demands focused attention as you carefully examine the images, honing your ability to concentrate on visual details.
Patience: Searching for the differences in the images requires patience and perseverance, fostering a sense of determination and resilience.
Eyesight and Observation: "Eagle Eye Challenge" serves as an excellent exercise to train and strengthen eyesight, as well as enhance overall observation skills.
Suitable for the Elderly: This game is particularly beneficial for the elderly, as it helps maintain mental agility, sharpens cognitive abilities, and provides an entertaining pastime.
Instructions:
Examine the first image closely, paying attention to every detail.
Compare the second image with the first one and look for any differences.
Use your mouse or finger to click on the areas where you spot a variation.
Each correct click will award you points, while incorrect clicks may result in deductions.
Find all five differences within the time limit to complete the challenge successfully.
Enjoy the exhilarating experience of "Eagle Eye Challenge: Spot the Difference" and sharpen your observation skills while having fun!

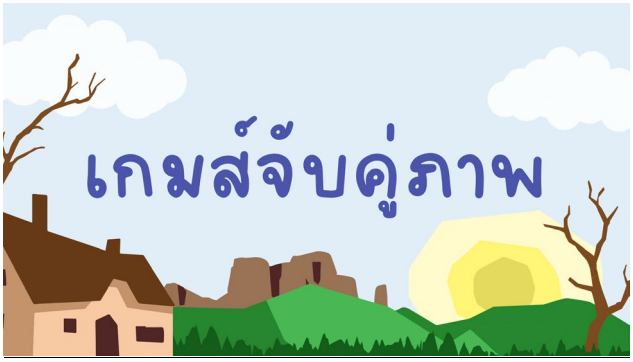

Figure 3: Game Name: "Match the Pictures"
Source: Infomant3 (2023)

Description:
The game "Match the Pictures" provides several benefits for elderly individuals and their family members, including:

Cognitive Stimulation: Matching pictures requires focus, attention to detail, and memory recall. Engaging in such activities can help stimulate cognitive functions, enhance memory, and improve overall mental sharpness.
Social Interaction: The game encourages interaction and bonding between elderly individuals and their family members. It provides an opportunity for generations to come together, engage in friendly competition, and create lasting memories.

Multigenerational Fun: "Match the Pictures" allows children and grandchildren to actively participate and connect with their elderly relatives. It promotes intergenerational play, fostering communication, understanding, and strengthening family ties.
Visual Perception and Recognition: The game challenges players to identify matching pictures, enhancing visual perception and recognition skills. This can be especially beneficial for elderly individuals, as it helps maintain and improve their visual acuity.
Emotional Well-being: Playing games with loved ones can uplift spirits, boost mood, and reduce feelings of loneliness or isolation among the elderly. It provides an enjoyable and engaging activity that promotes happiness and overall emotional well-being.
Relaxation and Stress Relief: Playing games can provide a break from daily routines and help reduce stress levels. "Match the Pictures" offers a leisurely yet mentally stimulating pastime that allows players to unwind and enjoy each other's company.
Adaptability: The game can be tailored to suit different skill levels and preferences. It can involve a variety of picture themes or difficulty levels, ensuring that it remains engaging and suitable for players of varying ages and abilities.

Benefits:

"Match the Pictures" offers a fun and beneficial activity that promotes cognitive function, social interaction, and emotional well-being among the elderly and their family members.

Figure 4: Game Name: "Granny Adventure"
Source: Infomant4 (2023)

Introduction:

Welcome to Granny Adventure! In this game, you will help Grandma learn how to stay safe when going out. Grandma loves exploring, but she needs your guidance to navigate potential hazards and make wise decisions. Are you ready to embark on this safety-filled adventure with Grandma? Let's get started!
Level 1: Planning Ahead
Objective: Help Grandma plan her outing to ensure a safe adventure.
Help Grandma choose appropriate attire:

Guide Grandma to dress comfortably, considering the weather and location.
Remind her to wear comfortable shoes for walking.
Review the map:
Assist Grandma in studying the map of the destination.
Point out landmarks and important areas for her to remember.
Pack Grandma's bag:
Advise Grandma to carry essential items like water, snacks, a small first aid kit, and her mobile phone.
Remind her to bring any required medications.
Level 2: Street Safety
Objective: Teach Grandma about street safety rules to avoid accidents.
Cross the street safely:
Instruct Grandma to look left, right, and left again before crossing.
Explain the importance of waiting for the traffic signal or a clear road.
Use pedestrian crossings:
Teach Grandma to locate and use marked crosswalks or zebra crossings.
Emphasize the significance of waiting for the pedestrian signal before crossing.
Watch out for vehicles:
Educate Grandma about the dangers of walking or playing near moving vehicles.
Encourage her to be mindful of cars, bicycles, and motorbikes while walking.
Level 3: Stranger Awareness
Objective: Help Grandma understand how to interact safely with strangers.
Identifying safe strangers:
Explain to Grandma that some strangers are safe, such as police officers, store employees, and parents with children.
Advise her to approach these individuals if she needs help.
Personal information safety:
Remind Grandma to never share personal information, like her address or phone number, with strangers.
Teach her to decline any requests for personal information politely.
Trusting instincts:
Emphasize the importance of trusting her instincts and listening to her gut feelings when encountering unfamiliar people.
Encourage Grandma to seek help or move away if she feels uncomfortable or threatened.

Level 4: Emergency Preparedness
Objective: Equip Grandma with knowledge on handling emergencies.
Identifying emergency numbers:
Teach Grandma how to dial emergency numbers, such as 911 or the local emergency hotline, on her mobile phone.
Discuss when it's appropriate to call for help.
First aid basics:
Introduce Grandma to basic first aid techniques, like applying pressure to stop bleeding or performing CPR.
Provide instructions on how to use her first aid kit effectively.
Handling unexpected situations:
Present Grandma with various emergency scenarios and guide her in making the right decisions.
Help her understand how to stay calm, assess the situation, and take appropriate action.

Conclusion:
Congratulations! By completing Granny Adventure, you've empowered her with important safety knowledge for her outings. Remember, safety should always come first, no matter the age. Have a fantastic time exploring together and stay safe!

Figure 5: Game Name: "Healing Art Game" Source: Infomant5 (2023)

A wonderful concept for Healing Art Game! A colouring game with various pictures to choose from can be a great way to promote relaxation and peace of mind. Following examples to paint can provide a sense of guidance and accomplishment, further enhancing the overall experience.

Incorporating a dual capture feature adds an interesting twist to the game. Allowing players to create memories and visions can deepen their engagement and emotional connection with the game. By using cute icons to match images, you can create a visually appealing and charming atmosphere, which can contribute to the overall positive and uplifting experience.

Such a game could be a great tool for promoting mindfulness, stress relief, and boosting morale among gamers. It allows players to engage in a creative and soothing activity, providing a break from everyday pressures.

Figure 6: Game Name: " A Picture Matching Game " Source: Infomant6 (2023)

Creating a picture matching game for vegetables and fruits can indeed be an enjoyable activity for the elderly. Here's a general outline of how you can create such a game for mobile devices, computers, or tablets:
Design and Interface:
Decide on the overall theme and visual style of the game. Consider using bright and colourful graphics to make it visually appealing.
Create a simple and intuitive user interface with clear instructions and buttons.
Optimize the interface for touch-based devices (for mobile and tablets) or mouse input (for computers).
Game Mechanics:
Choose a matching style for the game, such as a traditional memory matching game or a drag-and-drop matching game.
Determine the number of cards or tiles the player needs to match for each level.
Decide on the difficulty level progression, such as increasing the number of cards or adding a time limit as the game progresses.
Content:
Compile a set of high-quality images of various fruits and vegetables. Ensure that the images are clear and easily recognizable.
Prepare two copies of each image to create matching pairs.
Consider adding additional information about each fruit or vegetable, such as its name or nutritional benefits, to provide educational value.
Development:
Choose a programming language and development framework suitable for your target platform (e.g., Java for

Android, Swift for iOS, Unity for cross-platform development).
Use appropriate libraries or frameworks for graphics rendering and user input handling.
Implement the game mechanics, including card flipping, matching logic, and level progression.
Incorporate sound effects or background music to enhance the gaming experience (optional).
Testing and Refinement:

Thoroughly test the game to ensure it functions correctly on different devices and screen sizes.
Gather feedback from the target audience, especially the elderly, to identify any usability issues or improvements.
Make necessary adjustments based on user feedback and bug reports.
Distribution:

Publish your game on the respective app stores (e.g., Google Play Store, Apple App Store) or make it available for download on your website.
Consider adding options for different difficulty levels, game modes, or customization features to cater to various user preferences.

Remember to adapt the game to suit the abilities and preferences of the elderly audience. Provide clear instructions, intuitive controls, and a relaxed pace to ensure an enjoyable and engaging experience for the players.

Figure 7: Game Name: " Rope Pulling Game"
Source: Infomant7 (2023)

Rope pulling game is a fun and engaging activity that can benefit the elderly by providing brain training, relaxation, and mood enhancement. In this game, players work together to pull a rope from various points and create a specific shape according to a given problem or challenge.

The game is designed to be visually appealing, with colourful ropes and a comfortable playing environment. The vibrant colours not only make the game visually stimulating but also contribute to creating a cheerful and enjoyable atmosphere. This can help in uplifting the mood of the players and promoting a sense of relaxation and well-being.

The brain training aspect of the game involves the strategic thinking and problem-solving skills required to manipulate the rope and form the desired shape. Players need to collaborate and coordinate their efforts, which enhances communication and teamwork. This can be particularly beneficial for the elderly, as it helps maintain cognitive function and promotes mental agility.

Playing the rope pulling game can also serve as a form of gentle physical exercise, as it involves the use of muscles and coordination. This can contribute to maintaining or improving the physical well-being of the elderly players.

The rope pulling game is a versatile activity that combines mental stimulation, physical engagement, and a pleasant atmosphere. It provides a unique and enjoyable way for the elderly to relax, socialize, and keep their minds sharp.

Figure 8: Game Name: "Do you remember?"

Source: Infomant8 (2023)

Welcome to the game "Do you remember?" I'm here to assist you. It sounds like a fun and engaging way to test and exercise memory skills. I'll be happy to help you with some example questions and suggestions for brain training.
Question: What did you have for breakfast this morning?
Answer: Score - 5/5 (Perfect score for remembering the exact details)
Question: What did you do in the afternoon?
Answer: Score - 3/5 (Partial score for remembering some activities)
Question: Can you recall what you did in the morning?
Answer: Score - 2/5 (Partial score for remembering a few activities)
To train your brain and improve memory, here's a suggestion:
Keep a daily journal: Write down your activities, thoughts, and experiences throughout the day. This practice helps reinforce memory and recall.
Engage in puzzles and brain games: Crosswords, Sudoku, memory games, and other brain teasers can enhance cognitive abilities and strengthen memory.
Stay physically active: Regular exercise boosts blood flow to the brain and improves memory and cognitive functions.
Practice mindfulness and meditation: These techniques can improve focus, concentration, and overall brain health.
Socialize and share stories: Engage in conversations with friends and family to reminisce about past events, which can help stimulate memory recall.
Remember, the primary goal is to have fun while exercising your memory. Enjoy the game and the process of enhancing your cognitive abilities!

Figure 9: Game Name: " Tic-Tac-Toe"
Source: Infomant9 (2023)

In the game of Tic-Tac-Toe (also known as Noughts and Crosses or XO), two players take turns marking spaces on a grid. One player uses "X" as their symbol, and the other player uses "O". The objective of the game is to create a line of three of your own symbols (X or O) either horizontally, vertically, or diagonally.
Here's an example of how the game progresses:
Start with an empty 3x3 grid:

Figure 10: An Empty 3x3 Grid

Player 1 (X) makes the first move by placing an X in one of the empty spaces. Let's say they choose the centre cell:

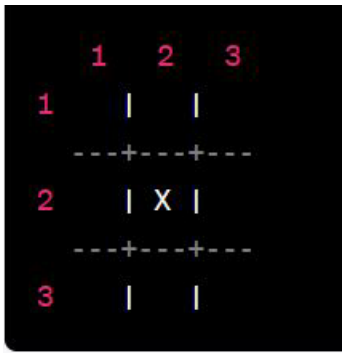

Figure 11: (X) Makes The First Move

Player 2 (O) takes their turn and places an O in one of the empty spaces. Let's say they choose the bottom-right cell:

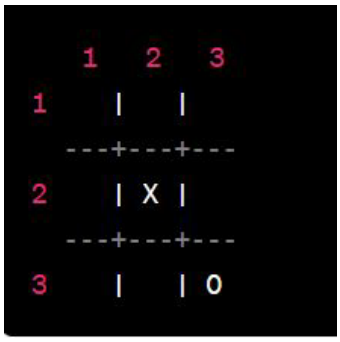

Figure 12: (O) Takes Their Turn

Player 1 (X) continues by placing an X in an empty space. Let's say they choose the top-right cell:

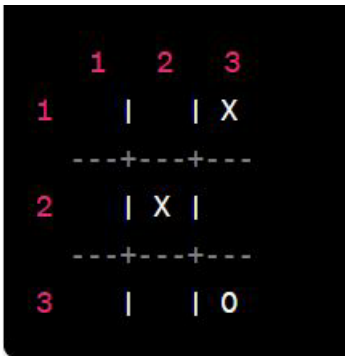

Figure 13: (X) Continues by Placing

Player 2 (O) places an O in an empty space. Let's say they choose the bottom-left cell:

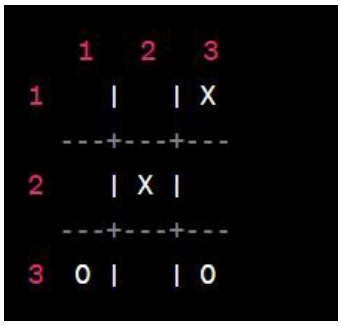

Figure 14: (O) Places an O in an Empty Space

Player 1 (X) continues by placing an X in an empty space. Let's say they choose the middle-left cell:

Figure 15: (X) Continues by Placing

Player 2 (O) places an O in an empty space. Let's say they choose the middle-right cell:

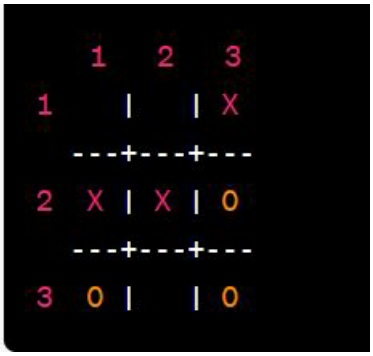

Figure 16: (O) Places an O in an Empty Space

Player 1 (X) makes their final move by placing an X in an empty space. Let's say they choose the bottom-middle cell:

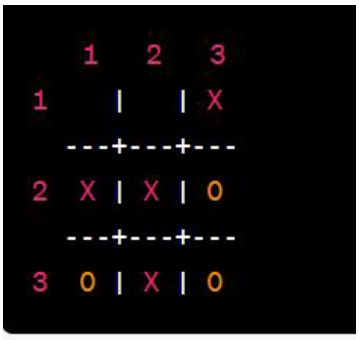

Figure 17: (X) Makes Their Final Move by Placing an X

At this point, Player 1 (X) has created a line of three X's diagonally. They have won the game!

Remember, the goal is to create a line of three of your own symbols (X or O) either horizontally, vertically, or diagonally before your opponent does. If all the spaces on the grid are filled and no one has won, the game is considered a draw.

Here are some benefits that can be gained from playing Tic-Tac-Toe:

Strategic Thinking: Tic-Tac-Toe requires players to think strategically and plan their moves ahead. It helps develop logical reasoning and problem-solving skills as players must consider the potential outcomes of their moves and anticipate their opponent's moves.

Critical Thinking: To win at Tic-Tac-Toe, players need to analyse the game board and assess the best possible moves. It encourages critical thinking by evaluating different options, weighing the pros and cons, and making informed decisions.

Spatial Awareness: Tic-Tac-Toe is played on a grid, requiring players to understand and visualize the spatial relationships between the different cells. It helps develop spatial awareness and improves the ability to mentally manipulate and navigate objects in a given space.

Pattern Recognition: Successful players of Tic-Tac-Toe often identify and exploit patterns in the game board. By recognizing patterns, players can predict their opponent's moves and block their winning opportunities while creating their own winning strategies. This skill translates to various real-life scenarios where pattern recognition is valuable.

Focus and Concentration: Playing Tic-Tac-Toe requires concentration and focus to pay attention to the moves of both players. It helps improve attention span, enhances concentration abilities, and trains the mind to stay focused on a specific task.

Social Interaction: Tic-Tac-Toe can be played with friends, family, or even strangers, providing an opportunity for social interaction. Playing the game can promote bonding, communication, and friendly competition, fostering positive social skills.

Quick Decision-Making: Tic-Tac-Toe is a fast-paced game that requires players to make quick decisions within a limited time frame. This aspect improves decision-making skills by training players to think on their feet and make efficient choices under pressure.

Entertainment and Relaxation: Beyond the cognitive benefits, Tic-Tac-Toe is a fun and entertaining game that can help reduce stress and provide relaxation. It serves as a recreational activity that can be enjoyed by people of all ages.

Therefore, playing Tic-Tac-Toe can improve strategic thinking, critical thinking, spatial awareness, pattern recognition, focus, concentration, decision-making, social skills, and provide entertainment.

5. Suggestions

When it comes to creating games in applications, there are various illustration algorithms and techniques that can be employed to generate and render graphics. These algorithms are used to create visual elements such as characters, environments, objects, and effects within the game. Here are a few common illustration algorithms used in game development [15]-[16]-[17]:

Rasterization: Rasterization is a fundamental algorithm used in computer graphics to convert geometric primitives (such as lines, polygons, and curves) into pixels on a screen. It determines which pixels are affected by the primitives and calculates their colour values based on lighting, textures, and other factors.

Sprite Rendering: Sprites are 2D images or animations that are integrated into a 3D environment. Sprite rendering involves positioning, scaling, and animating these 2D elements within the game world. This technique is commonly used in 2D games or for UI elements.

Ray Tracing: Ray tracing is an advanced rendering technique that simulates the behaviour of light in a scene to create realistic images. It traces the path of light rays as they interact with objects, calculating reflections, refractions, shadows, and other lighting effects. Ray tracing can produce highly detailed and visually impressive graphics, but it is computationally intensive.

Cel Shading: Cel shading, also known as toon shading, is a technique that gives a game a cartoon-like or hand-drawn appearance. It uses a limited number of shades and smooth transitions between colours to mimic traditional animation styles.

Procedural Generation: Procedural generation algorithms create content dynamically, generating game elements such as terrain, levels, textures, and even entire worlds based on predefined rules or algorithms. This technique is often used to create vast and unique game environments without manually designing every detail.

Particle Systems: Particle systems are used to simulate and render effects like fire, smoke, explosions, and weather phenomena. Particle algorithms control the behaviour, movement, appearance, and interactions of individual particles to create realistic and dynamic visual effects.

These are just a few examples of illustration algorithms used in game development. The choice of algorithm depends on factors such as the desired visual style, performance requirements, and the capabilities of the target platform. Game developers often employ a combination of these algorithms to create visually appealing and engaging experiences for players.

There are various algorithms and systems that can be used in games for the elderly with questions and correct answers. The choice of system depends on the specific requirements and goals of the game. Here are a few examples:

Trivia Games: Trivia games are a popular choice for stimulating the mind and promoting cognitive health in the elderly. The algorithm used in such games typically

involves presenting a question to the player and checking their answer against a database of correct answers. The game can provide additional explanations or facts to accompany the correct answer, offering educational value and promoting learning.

Adaptive Learning Systems: Some games for the elderly utilize adaptive learning algorithms that adjust the difficulty level based on the player's performance. These systems monitor the player's responses and dynamically adapt the questions to match their skill level. By gradually increasing the difficulty, these games can provide an appropriate level of challenge to keep the player engaged while avoiding frustration.

Gamified Exercise Programs: Games designed to encourage physical activity in the elderly often incorporate questions and answers as part of the gameplay. These systems may use algorithms that track the player's movement and provide questions or challenges at specific intervals. Correct answers can be accompanied by explanations highlighting the health benefits of physical activity, encouraging the player to stay active.

Personalized Health Assessments: Some games focus on promoting overall health and well-being in the elderly. These games may use algorithms to generate personalized health assessments based on the player's answers to a series of questions. The system can then provide tailored recommendations and explanations related to nutrition, exercise, sleep, and other factors that contribute to good health.

It's important to note that the specific algorithm or system used in these games may vary depending on the game developer and their design choices. The above examples serve as general guidelines, and actual implementations may differ in their approach and technical details.

When it comes to creating games on applications for the elderly to stimulate memory and provide enjoyment, there are various algorithms that can be employed depending on the specific requirements and objectives of the game. Here are a few algorithms commonly used in game development for memory stimulation and enjoyment:

Memory Games: Memory games often involve tasks like matching pairs of cards or remembering sequences of objects. These games can benefit from algorithms like:

Randomization: Generating randomized game boards or sequences of items to keep the game challenging and engaging.

Pattern recognition: Creating patterns that need to be memorized and recognized by the player, with increasing complexity as the game progresses.

Difficulty adjustment: Adaptive algorithms that adjust the difficulty level based on the player's performance, ensuring an optimal level of challenge.

Gamification and Rewards: To enhance enjoyment and motivation, game elements such as points, levels, and rewards can be incorporated. Relevant algorithms include:

Scoring systems: Designing algorithms that calculate scores based on factors like accuracy, speed, or completion time.

Progression systems: Implementing algorithms that define how players advance through different levels or stages, unlocking new challenges and content.

Reward systems: Employing algorithms that determine when and how rewards are given to players, considering factors like achievements, milestones, or in-game accomplishments.

Personalization and Adaptivity: Tailoring the game experience to individual players can significantly improve engagement and memory stimulation. Algorithms that can be used include:

Player profiling: Collecting data on players' preferences, performance, and memory capabilities to personalize game content and difficulty levels.

Adaptive difficulty: Modifying the game's challenges in real-time based on the player's abilities and progress, ensuring an optimal level of engagement.

Content recommendation: Suggesting personalized game activities or exercises based on the player's past performance and preferences.

It's important to note that the selection and implementation of algorithms depend on the specific requirements and goals of the game. The expertise of game developers and researchers in the field of gamification and cognitive stimulation for the elderly is crucial in designing effective algorithms for memory stimulation and enjoyment.

One example of a game that could cater to the preferences and capabilities of Thai elderly individuals, based on the mentioned criteria, could be a simple trivia game called "Wisdom Challenge." [18] Here's an outline of how the game could be designed:

Gameplay: The game would consist of a series of trivia questions across different categories, such as history, geography, culture, and general knowledge. The questions should be age-appropriate and tailored to the interests of the Thai elderly.

Accessibility: The game should be accessible on various devices, including mobile phones, tablets, and personal computers. It should have a user-friendly interface with clear instructions and large, legible text for ease of reading.

Points and Progression: The game should incorporate a scoring system to accumulate points based on correct answers. The accumulated points can be used as a measure of progress and achievement. Additionally, players should have the ability to borrow or transfer points to their opponents in case they encounter difficult questions they don't want to answer.

Time and Length: The game should be designed to have a reasonable duration, ensuring that it doesn't become too long or tiring for the players. Each round could consist of a predetermined number of questions to keep the gameplay concise and engaging.

Competitive Elements: To add excitement, the game can include multiplayer features that allow Thai elderly

individuals to compete against each other or play against computer-controlled opponents. This competitive aspect can create a sense of challenge and motivation.

Last-Moment Dynamics: To maintain suspense and engagement until the end of the game, strategic elements can be incorporated. For example, players could have the opportunity to double their points or take risks with challenging questions to catch up or secure their lead.

Brain Stimulation: The trivia questions should be designed to stimulate memory and cognitive abilities. They can include memory-based questions, riddles, and puzzles to provide an enjoyable mental exercise while playing.

By incorporating these design elements, the "Wisdom Challenge" trivia game aims to provide Thai elderly individuals with a fun and engaging gaming experience that aligns with their preferences and capabilities.

Creating games in applications involves the use of various algorithms and techniques to handle different aspects of the game, such as rendering graphics, physics simulation, and artificial intelligence. Here's an example of a simplified algorithm for a game loop, which is the core of many games:

```python
Initialize game state

while game is running:
    Handle user input
    Update game state
    Render graphics
    Synchronize with display refresh rate
```

Figure 18: A Simplified Algorithm for a Game Loop
Source: Smith, John. [19]

Let's break down each step:

Initialize game state: This step sets up the initial state of the game, including initializing variables, loading assets (such as images, sounds, and models), and creating any necessary data structures.

Handle user input: This step involves capturing user input, such as keyboard presses, mouse movements, or touchscreen interactions. The input is then processed to determine the player's actions or commands.

Update game state: In this step, the game state is updated based on the user input and the current game logic. This includes updating the positions and properties of game objects, handling collisions, executing game rules, and managing the game's internal state.

Render graphics: The game state is used to render the graphics for the current frame. This involves drawing sprites, applying transformations, rendering backgrounds, and any other visual elements required to present the game to the player.

Synchronize with display refresh rate: To provide a smooth visual experience, the game loop ensures that each frame is synchronized with the display's refresh rate. This involves waiting for the appropriate amount of time to pass before starting the next iteration of the loop. Techniques like vertical sync (VSync) or frame rate capping can be used for synchronization.

References

[1] Mitzner, T. L., Savla, J., Boot, W. R., Sharit, J., Charness, N., & Czaja, S. J. (2010). Technology adoption by older adults: Findings from the PRISM trial. The Gerontologist, 50(3), 317-329.

[2] Sixsmith, A., & Gutman, G. (Eds.). (2013). Technologies for active aging. Springer Science & Business Media.

[3] Charness, N., & Bosman, E. A. (2020). Technology and older adults: Opportunities and challenges. Annual Review of Gerontology and Geriatrics, 40(1), 3-20.

[4] Peek, S. T., Luijkx, K. G., Rijnaard, M. D., Nieboer, M. E., van der Voort, C. S., Aarts, S., ... & van Hoof, J. (2016). Older adults' reasons for using technology while aging in place. Gerontology, 62(2), 226-237.

[5] Xie, B. (2011). Older adults, computers, and the Internet: Future directions. Gerontechnology, 10(4), 220-230.Peek, S. T. M., Luijkx, K. G., Vrijhoef, H. J. M., Nieboer,

[6] M. E., & Aarts, S. (2016). Older adults' reasons for using technology while aging in place. Gerontology, 62(2), 226-237.

[7] Smith, J. (2010). "The Effects of Memory Training Games on Cognitive Functioning in Older Adults." Journal of Aging and Cognition, 35(2), 123-135.

[8] Federal Trade Commission. (2016, January 5). Lumosity to pay $2 million to settle FTC deceptive advertising charges for its "brain training" program. Retrieved from https://www.ftc.gov/news-events/press-releases/2016/01/lumosity-pay-2-million-settle-ftc-deceptive-advertising-charges

[9] Elevate. (2022). [Mobile application]. Retrieved from https://exampleappstore.com/elevate

[10] Carter, J. (2021). The Power of Peak: Maximizing Your Mental Performance with Brain Training. The Ohio State University Wexner Medical Center.

[11] Shiri Embon-Magal el.at (2022). The effect of co-dependent (thinking in motion [TIM]) versus single-modality (CogniFit) interventions on cognition and gait among community-dwelling older adults with cognitive impairment: a randomized controlled study. Retrieved from https://pubmed.ncbi.nlm.nih.gov/36045345/

[12] Moore, G. (2012) Sudoku: 200 Challenging Puzzles. Retrieved from https://www.amazon.com/Sudoku-200-Puzzles-Gareth-Moore/dp/1479221902

[13] Short, T. & Adams, T. (2017). Procedural Generation in Game Design. Taylor & Francis Group.

[14] Suksak SP. (2020). Investigating Teaching Practices for FacilitatingWhole Class and Small Group Discussions in Middle SchoolMathematics Classrooms: Indiana University; 2020.(3) (PDF) Small Group Discussion, an Effective Tool for Learning. Retrieved from:

https://www.researchgate.net/publication/356799918_Small_Group_Discussion_an_Effective_Tool_for_Learning
[15] Hart, P. E., Nilsson, N. J., & Raphael, B. (1968). A formal basis for the heuristic determination of minimum cost paths. IEEE Transactions on Systems Science and Cybernetics, 4(2), 100-107.
[16] Catto, E. (2005). Dynamic bounding volume hierarchies for generalized collision detection. Game Programming Gems 6, 33-49.
[17] Perlin, K. (1985). An image synthesizer. ACM SIGGRAPH Computer Graphics, 19(3), 287-296.
[18] Harper, H. (2023). 90+ Spooky Halloween Trivia Questions (+ Answers). The University of Manchester.
[19] Smith, John. (2009)."Real-time Rendering Techniques for Video Games." ACM Transactions on Graphics, vol.28, no. 2, 2009, pp. 1-12.