THE REPUBLIC OF TURKEY
BAHCESEHIR UNIVERSITY

THE EFFECTS OF MOBILE GAMES ON COGNITIVE ABILITIES FOR ELDERLY

Master's Thesis

ÇAĞATAY ÇİLOĞLU

İSTANBUL, 2018

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ABSTRACT

THE EFFECTS OF MOBILE GAMES ON COGNITIVE ABILITIES FOR ELDERLY

Çağatay ÇİLOĞLU

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This study examined the effects of digital games and serious games on the cognitive abilities of the elderly, to meet their needs, provide motivation and game experience survey for measurement is based on literature review. Like all living creature, human race will be getting old, which this situation is not tied to us, but it is depends on us aging healthy and successful. One of the most challenging factors for the elderly is the decrease in their cognitive abilities, yet these abilities can be recovered with mental activities. With the development of technology these activities are now more varieties in virtual environments. However, there are a lot of gaming platforms, mobile devices are the most suitable for the elderly because of the usability, learnability and memorability. Senior have adapted to mobile phone games much more easily and have had a lot of fun. The case study was made with one platform-based game and four serious games for smartphones with a group of seniors from Turkey, observe the effects of platform-based games on cognitive abilities. There is a meaningful and positive relationship between GeceKusu platform game and FitBrains test ($r[9] = 0.61$, $p = 0.05$). The focus, logic, visual and speed abilities were increased individually in all participants.

Keywords: Elderly, Mobile Games, Motivation, Cognitive Skills

ÖZET

YAŞLILAR İÇİN MOBİL OYUNLARIN BİLİŞSEL YETENEKLERE ETKİLERİ

Çağatay ÇİLOĞLU

Yüksek Lisans, Bilgisayar Mühendisliği Yüksek Lisans Programı

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Bu çalışma, dijital oyunların ve ciddi oyunların yaşlıların bilişsel yetenekleri üzerindeki etkilerini, gereksinimlerini karşılamak, motivasyon sağlamak ve ölçüm için oyun deneyimi anketi literatür taramasına dayalı olarak incelenmiştir. Bütün canlılar gibi insan ırkı da yaşlanacaktır, bu durum bize bağlı değildir, ancak sağlıklı ve başarılı bir şekilde yaşlanmak bizim elimizdedir. Yaşlılar için en zorlu faktörlerden biri, bilişsel yeteneklerindeki azalmadır, ancak bu yetenekler zihinsel aktiviteler ile geri kazanılabilir. Teknolojinin gelişmesiyle, bu aktiviteler artık sanal ortamlarda daha fazla çeşitlilik göstermektedir. Ancak, bir çok oyun platformu vardır, kullanılabilirlik, öğrenilebilirlik ve hatırlanabilirlik nedeniyle mobil cihazlar yaşlılar için en uygun olanıdır. Yaşlı katılımcılar mobil telefon oyunlarına çok daha kolay uyum sağlamıştır ve eğlenceli vakit geçirmiştir. Vaka çalışması, Türkiye'den bir grup kıdemli ile akıllı telefon üzerinden bir platform tabanlı oyun ile dört ciddi oyun ile yapılmıştır, platform tabanlı oyunların bilişsel yetenekler üzerindeki etkileri gözlemlenmiştir. GeceKusu platform oyunu ve FitBrains testi arasında anlamlı ve pozitif bir ilişki vardır ($r[9] = 0.61$, $p = 0.05$). Tüm katılımcılarda odak, mantık, görsel ve hız yetenekleri bireysel olarak artış göstermiştir.

Anahtar kelimeler: Yaşlılar, Mobil Telefonlar, Motivasyon, Bilişsel Yetenekler

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SYMBOLS

α	:	Pearson Correlation
p	:	Significant Value
r	:	Correlation Coefficient

1. INTRODUCTION

The first known video game in history was made on October 18, 1958 by nuclear physicist William Higinbotham (Brookhaven National Laboratory 2008). It was a simple tennis game named Pong. From that day until today games are still in our lives and is constantly improving. Many researches show that the world population is aging. The United Nations Department of Economic and Social Affairs (DESA) tell that in 2017, there are 962 million people in the world over 60 years of age, which accounts for 13% of the global population. It is estimated that the number of elderly people in the world will be 1.4 billion in 2030, 2.1 billion in 2050 and 3.1 billion in 2100 (United Nations 2017). According to this data there is a considerable number of elderly populations and it is necessary to turn these people back to life again. "Platform based games have a positive effect on cognitive abilities of the elderly" hypothesis was proposed. Developing the suitable games for the old peoples is the key point to learning this answer. When the right environment is provided, it is very important to show positive effects of games, to have fun, to encourage efficient time passing and to reduce their stress on these elderly people. This type of games is much easier to reach on mobile devices for them. One of the most important problems for the elderly is the decrease of motor skills and it is aimed to bring these skills back with platform-based mobile games. To achieve this, show the importance of technology with mobile games, to love it and to provide motivation for old people.

Some segments of society still lack resources or adaptation for the elderly. With aging, people inevitably encounter various restrictions. Close memory loss, attention, detection, planning and decision making are some of them. But those ability may come back again. There are a lot of studies showing that games develop those abilities. Platform-based games may have a more positive effect on most of these important cognitive skills with it, their first game experiences must be on mobile devices so that they can adapt more easily to these games.

The most important issue in this study to ensure that older people play these games. Because there are lots of games, game types and game platforms. Like PC, PS4, Xbox One,

Wii U, PS Vita and more. An elderly person may fear if we talk about these varieties. But mobile phone use is more common, and it will be easier to be adapt for them. The number of mobile phone users worldwide are estimated at 4.77 billion for 2017. Mobile phone users around the world are expected to reach five billion by 2019. In 2016, 62.9 percent of the population worldwide, already has a mobile phone, in 2019 is expected to be 67. The number of smartphone users will reach about 2.5 billion in 2019 from 2.1 billion in 2016, and the smartphone sales ratios are expected to increase (Statista 2017). However, in general, existing games mainly focus on adolescent teenagers, children and adults. According to Newzoo's report, there are 2.2 billion active gamers in the world. Ten years after the iPhone was introduced to the market, mobile is the most profitable segment of the second year; Smartphone and tablet games are demanding 42% of the market with an increase of 19% year on year to reach 46.1 billion dollars (Global Games Market Report 2017).

The usability of games is a very important issue, especially for older individuals. Researches for the elderly are few and most of these games are done on computers or on game consoles that are no longer used. New technologies in the gaming industry is growing so fast. Studies aimed at understanding the aged people motivation for the use of digital games on mobile devices are uncommon and old (Ijsselsteijn et al. 2007; Flores et al. 2008; Fisk et al., 2009).

This study was done with 9 older than 65 years old adults. The study follows a mixed methodological approach that uses the in-Game Experience Questionnaire to assess the players' gaming experience and a correlational study, to examine the relationship between GeceKusu and FitBrains mobile application games scores. The learning effect was examined by comparing the average of the FitBrains game scores of the first and last game performances of each player.

It has been decided that mobile phones are the most suitable game console for the elderly because mobile devices are easy to play, not extra cost, variety of games and they able to play where they want which they are good source of motivation factors for the starters. So, this article aims to develop mobile game for older users that suit the preferences, needs and

interests with it bringing old people back to society. To spend entertaining time with mobile games and love to technology for elderly users is goal. The impact of mobile platform games on cognitive health of the elderly has been examined. Platform game is a type of two-dimensional video game where the player moves on the screen by moving, jumping or climbing the various characters on the screen.

This article is structured as follows. Section 2 presents literature review. Section 3 showed how the data were retrieved and method. Section 4 demonstrate the findings. Lastly Section presents 5 conclusion and discussion.

2. LITERATURE REVIEW

This section presents some studies related to games for seniors, mobile games and how intervenes in the use of motivational games. At the same time general knowledge about the health effects of cognitive skills and how useful they are if the games are chosen correctly.

2.1 COGNITIVE SKILLS AND ABILITIES

Cognition refers to conscious mental activities and involves thinking, reasoning, understanding, learning and remembering. Cognitive capacity is generally measured by intelligence department (IQ) tests. The brain uses the basic skills called cognitive skills to perform these activities. Cognitive abilities are brain-based skills that we must perform to accomplish any task, from the simplest to the most complex. The main functions of the brain involved in cognition are listed below as tables (Table 2.1).

Table 2.1: A brief description of each of the cognitive skills

Cognitive Skills Related with Brain Function	Related Skills
Perception	Recognition and interpretation of sensory stimuli such as smell, touch, hearing.
Attention	Ability to maintain and manage focus on a particular object, action, or thought.
Motor skills	The ability to move our muscles and bodies, and manipulate objects.
Visual and spatial processing	Ability to action incoming visual stimuli, to understand spatial relationship amid objects, and to visualize images and scenarios.
Memory	Limited storage include short-term memory and unlimited storage include long-term memory.
Language	Skills that allow us to transform voices into words and produce verbal output.
Executive Functions	Goal-directed behavior, such as providing planning skills and the ability to run a target. Among them: Flexibility: rapid mobility capacity in the appropriate mental mode. Problem solving: to identify the problem correctly, then to produce solutions and to choose the right one. Decision making: problem solving, lack of knowledge and decision-making ability based on our and others' emotions. Sequencing: the ability to divide complex actions into manageable units and prioritize them in the right order. Inhibition: the ability to ignore irrelevant stimuli or to suppress unrelated stimuli when performing a task.

Cognitive abilities are not fixed can be improved with lifestyle and practice. Along with age, some cognitive abilities, especially pseudo-executive functions and cognitive abilities that are not regularly used, are diminishing. Skills are categorized into cognitive and non-cognitive. Psychologists make a distinction between fluid intelligence and crystallized intelligence. Fluid intelligence is about the rate at which people learn, crystallized intelligence is acquired knowledge (Nisbett et al. 2012). IQ tests are often used to measure cognitive ability or intelligence. Term of non-cognitive skills to describe personal attributes is not being able to measure with IQ tests or achievement tests. It is shaped by families, schools and social environments.

2.2 GOOD AND BAD ASPECTS OF GAMES

Those who are unfamiliar with games are often prejudiced that games are time-wasting, money consuming and violent orientation. Concerns continue that the playing of violent video games increases the risk of aggression in the players. Beside of that there is no definite jurisdiction over whether games are completely harmful. There are many parameters such as education, family, culture, environment, age and type of game. However, there is a clear consensus that playing violent video games has increased aggressiveness. Numerous studies have shown that exposure to violent video games increases aggressive efficacy and aggressive cognitions (for instance, Anderson & Ford, 1986; Irwin & Gross, 1995; Kirsh et al., 2005). These potential damages seem to be related to aggression, addiction and depression. Similarly, in the findings of (Aison et al., 2002) all elderly participating in focus groups reported negative perceptions of violence in digital games.

The definition of the serious game mentioned in the literature, is the name given to the games designed for a different purpose than mere entertainment. The serious frontend is usually added to indicate video games used in areas such as defense, education, scientific discovery, health, crisis management, engineering and politics. With it, there are researches that games have positive effects on very important issues such as health, schooling, mental exercise and stress reduction. In the medical field, researchers and doctors are motivating patients to play video games in order to improve their health (Kato, 2010). According to

researchers, it has been observed that shooter game players are paying attention more efficiently and filtering out irrelevant information more effectively when working on more regular games than non-players (Bavelier, et al., 2012). Another positive study about the shooter showed the following results (Green & Bavelier, 2012), when compared, the players showed faster and more accurate attention distribution, higher spatial resolution in visual processing, and improved mental rotation capabilities. With the development of technology, the effects of games in the health field are increasing. The number of serious games is rapidly increasing in diagnosing or treating the disease. They are used in health sector such as diabetes management, diagnosis of Parkinson, blood management, medical knowledge, home birth management and many more. When all the research by done is examined, it is seen that the benefits of video games and serious games are higher.

2.2.1 Game Restrictions Encountered by the Elderly

Video games in the last decade are a popular leisure activity. According to Ijsselsteijn et al. (2007) digital games can be considered a promise to improve the lives of the elderly, but what is necessary for it enjoyable, interesting and accessible games should be developed for them and it must be beneficial.

As years go by, everyone will age physiologically, Czaja & Chin (2009) say that close memory loss and attention due to aging are often the most important skills that affect memory. The reduction of these abilities can directly affect the daily life of the elderly. But it is known that games are positive effects on brain training. The only problem is they must be suitable and encouraging for them.

Develop technological for elderly must be solutions aimed at better usability and accessibility to reduce barriers. Ijsselsteijn et al. (2007) reported some restrictions related to age progression like the decline in visual accommodation and contrast sensitivity, as a solution to this zooming, high definition color contrast and the resizing of windows is recommended. Sensing technology when designing for older people, age-related changes in cognitive and motor system is important (Fisk et al., 2009).

One of the other problems is older people see computer interfaces as overly technical and difficult to use because they are out of technology. Search keys on the keyboard and difficult to see create big problems. Their mouse controls are pretty weak also gaming computers appear as a luxury consumption and the games are quite expensive. Because of these reasons, make them play computer games as a first experience it is even more difficult to with older users. This situation will make them sad rather than entertaining. But mobile games will be easier to play with the appropriate interface and most of them is free, it will be motivating for them.

2.2.2 Video Games and Technology for the Elderly

Technology helps seniors to stay in touch with their parents, friends or grandchildren, enabling them to communicate better and providing more access to information. It should be told well that technology makes life easier. The benefits and entertainment of games make technology more attractive when shown to them. It is important remind elderly people to that there are too many applications and serious games in the health field if they are using smartphones.

Some researchers have explained the following points to consider when making a product for the elderly (Fisk et al., 2004) tell that "usability" is the possibility to have access to a product and describe "utility" as the ability of the product to provide its functionality. In addition, they define five features specifically related to usability:

i) Learnability: how difficult it is to learn to use a device, to understand and to integrate functioning instruction. The time required to complete a task correctly and the results obtained over a period of time are possible measures learnability.

ii) Efficiency: to what extent the technological applications satisfy the users, by avoiding time loss, frustration and dissatisfaction. It can be the performance of a particular task measured by an experienced user.

iii) Memorability: is very important to prevent the disappointment of the old users and the waste of time.

iv) Errors: how easily a product can make mistakes for older users and how easy it

is to recover them.

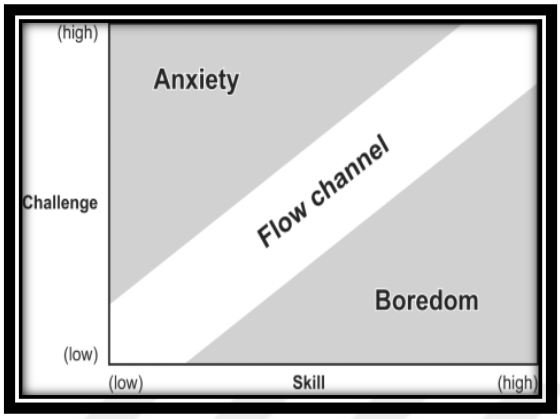
v) Satisfaction: the adoption of attitudes and technological applications can be affected by the likelihood of their use.

Hsiao (2007) point out games affect many aspects of the community including social, political, economic and technologic. Games are growing in popularity among people of different ages, genders and cultures. Activities that challenge the mind, such as playing games, doing crafts, and solving puzzles will strengthen the cognitive skills. It would be very useful to make them as everyday activities. The participation of the elderly in cognitive activities will help keep their minds active and will help them hold on to life. Elderly activities should always be age-appropriate, because it is important to protect the self-respect and pride of the individuals.

2.3 MOTIVATION

According to Frey & Osterloh (2002) there are two types of motivation, Intrinsic and Extrinsic motivation. Intrinsic motivation is valuable for its own sake and seem self-permanent and enables the production and transmission of hidden information under circumstances. Extrinsic motivation is like financial gain due to the completion of certain tasks. Intrinsic motivation theory, explains the reasons that lead people to engage in certain activities without a specific purpose. The Theory of Flow was proposed by the American psychologist Mihaly Csikszentmihalyi in 1970. It is based on an investigation aimed at analyzing people's emotions in certain activities. He found that the cognitive and emotional state is associated with degrees of skill and difficulty in performing a particular activity. If the ability is weak due to difficulty of the activity, it causes anxiety in the person. If it is high, it causes boredom. For the success of flow state, the ability and level of challenge must be balanced. Figure 2.1 shows the process to get the flow status.

Figure 2.1: Flow state model



Based on the Flow Theory, Sweetser & Wyeth (2005) offered a discovery to evaluate entertainment in games, named GameFlow model. The GameFlow model consists of eight elements: concentration, challenge, skills, control, clear goals, feedback, immersion and social interaction. Each of these items has been suggested to make the game fun.

2.3.1 Cognitive Benefits of Video Games

Serious games and puzzle games are excellent cognitive activities for seniors. Standard games like chess, checkers, dominoes, scrabble and puzzle games like jigsaw puzzle, crossword, sudoku are the games that improve mind in the cognitive field. Reaching such games is much easier on mobile devices and there are so much variety. The benefits of such games have been explored on other devices. However, due to the passage of years the game platforms such as Atari Arcade Machine and Gameboy which mentioned in the literature are no longer used (Dustman et al., 1992). Besides of these games, there are also researches for other game types. But, research conducted for a new generation of games is quite limited. Published in 2004, Microsoft's Rise of Nations game was played by healthy elderly adults for 23 hours, it was a strategy game and proved to be beneficial to the talents of planning and organization (Basak et al., 2008). Another proven new generation research; in a study published in the Nature Journal researchers Anguera et al., (2013) discovered that changing directions around cars while driving and simultaneously look out road signs a video game can improve short-term memory and long-term focus of older adults. A group between the ages of 60-85 play a game called NeuroRacer for on a laptop at home for 1 h a

day, 3 times a week for 4 weeks (12 h of training in total). Six months after playing the game, older adults were more successful in multi-tasking, soon acquiring more information, and more attentive.

It has been found that each of the different types of games has separately positive effects on motor performance and cognitive ability. Games of the platform type will have positive impact on many talents. So, it can be said that serious games and digital games will provide successful aging for the elderly.

2.3.2 Mobile Serious Games and Motivation for Elderly

Motivation is the word derived from the word "motive" which means needs, desires, wants or drives within the individuals. For that reason, it is important game must be attractive. Be motivated to do something, it allows a person to spend more time in an event.

Motivation is the most important factor in learning and if the process is fun at the same time it makes people happy. Other factors that may contribute positively to health and improve physical constraints may also affect this behavior. Also, many research shows that playing video games improved self-esteem of older people. Like, (Goldstein et al., 1997) found that in his study five hours a week playing digital games for five weeks, improved response times, developing self-esteem and a sense of well-being for the elderly actors.

Flores et al. (2008) rank some criteria for evaluating motivation to play games: appropriate cognitive challenge, easy goals and interface, social activity element, appropriateness of genre, new learning creation, decreased sensory acuity and slower responses. Because of this the games should be simple, fun and rewarding. Interaction games were produced along with developing technology, digital games now enable the movement of the whole body. Game consoles like the Nintendo Wii are especially effective to help people develop hand-eye coordination. Users can increase their coordination by physically moving an auditor to change objects on the screen. Some of the games available on the Wii include dancing, shifting your legs and waving your arms. It is a good way for an elderly person to have fun and so that the entire family can be involved.

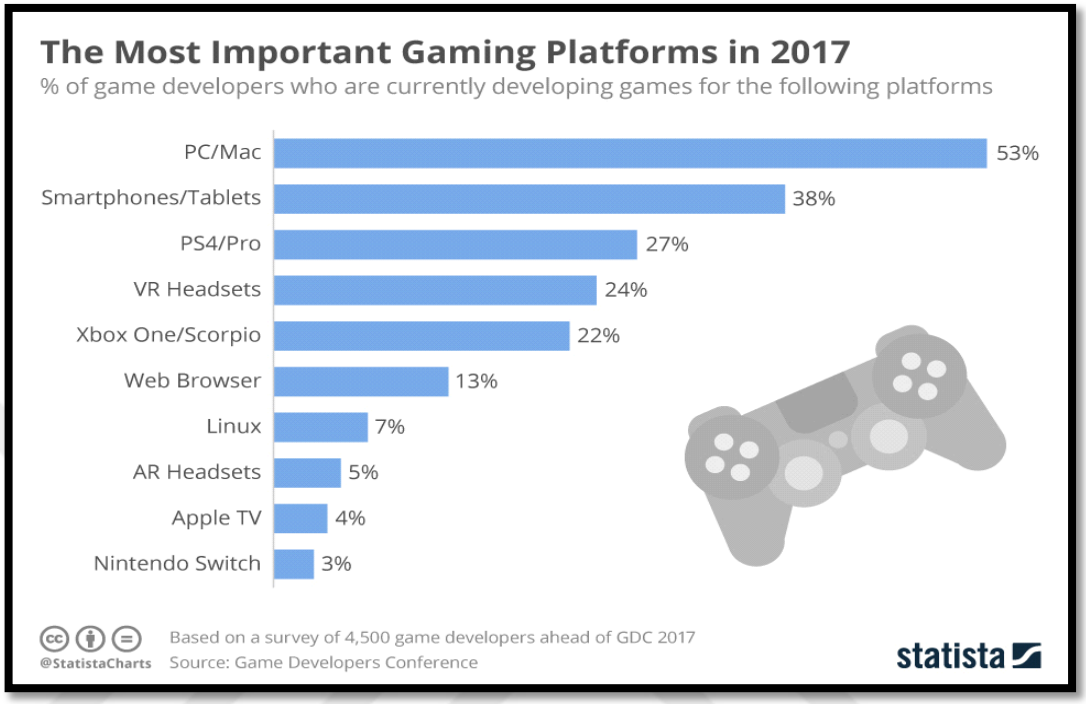
The term used for games available on mobile devices is called mobile games, these include mobile phones, smartphones, PDAs and notebooks. Games on mobile devices are still rarely studied, but research by these authors Yee et al. (2010) suggests that using mobile devices by humans in general, including the elderly, is a promising challenge. Two factors are required when developing a software; having good usability and meet their interests, requests and demands, it is necessary for motivation to meet the expectations of users. Meeting these needs will be fairly easy due to the popularity of mobile devices. It should not be forgotten that the difficulties on usability will affect the motivation assessment process and success.

2.3.3 Mobile Games vs Other Game Platforms Ease of Use for Elderly

There are a lot of studies showing the benefits of games as well as having fun, social and cultural influences on the person. But, because of the popularity of games there are many game platforms and different modes of play. PC/Mac, Smartphones/Tablets, PS4/Pro, VR Headsets, Xbox One/Scorpio, Nintendo Switch are the most important gaming platforms. There are also different tools for these platforms, gamepad, joystick, keyboard and mouse, racing wheels for motorsport etc. are some of them. This is confusing for even young individuals who are stranger for the digital games, it is much more difficult and frightening for older people.

Besides these, it's costly to have a good gaming PC and games are very expensive. Other platforms are less cheap but the number of games is few and much costlier. Those statistics in Table 2.2 show that PC games still ahead (Statista 2017), but the very first PC game Pong was produced in 1972. However, Tetris the first mobile game was introduced in 1994. Mobile games industry in recent years has shown a great improvement, it seems will continue to increase in the coming years and overtake the PC eventually. This potential should also develop games for the elderly person.

Table 2.2: The most preferred game consoles in 2017



Source: Statista; Game Developers Conference, February 2017

Along with the change in the standard of living it is difficult to say mobile phones are luxury, it would not be wrong to say it is almost necessary. The data in Section 1 shows this, it is also quite common among older peoples. The use of mobile phones instead of other game platforms will be easier for the elderly, which this will provide fun times. The adaptation process will be easier because mobile phones are used by many people. There are plenty of mobile gaming options to suit their needs, and many of these games are free. For these reasons, motivate older people to play game on mobile devices are the best option.

2.4 FIT BRAINS MENTAL EXERCISE GAME REVIEWS

Our brain ages with the aging of our bodies. Without care, the neural pathways in your brain deteriorate over time. Once it is gone, they cannot be repaired. But they can be rebuilt. Vivity Labs Chief Scientific Officer, renowned clinical neuropsychologist Dr. Paul Nussbaum has formulated Fit Brains brain games to expand memory by training the brain to create new neural pathways and to increase concentration and speed. Vivity Labs claims

that it improves brain performance and helps achieve the highest possible level of brain function.

The human brain always likes to play, there are many methods for brain training. Digital games provide accessible goals, give an easy way of measuring progress, and most importantly games are fun. Fit Brains offers diverse and complex mental activities such as user language games, memory games, concentration games, problem solving games and visual games. Fit Brains games targeting players between the ages of 17-88 are easy enough. These games have been designed to target a few key brain areas, including psychologists call “fluid intelligence”. Games for brain exercise are usually recommended 3 days a week and 15 minutes a day.

There are many positive reviews about this application. The common view about this application is that it has a lot of interesting games that help to increase concentration, memory and overall brain power. It is mentioned that the membership fee is reasonable considering what is offered. The common negative criticism about this application is that it does not contain games for children. Although it does not have games directed towards elderly people, it includes games in which the elderly can adapt easily.

3. DATA AND METHOD

This section is intended to explain the game played on the smart mobile phone, how to use it, and the collected data. The cognitive skills of the elderly people involved in this study will be measured by an application named FitBrains. The positive side of the game, impacts on health, spend fun times and protection of self-respect are the main goals. Playing mobile phone games will be effective in adapting to be easier. It is important to motivate the elderly by such methods. All games were played on HTC One_M8 Android smartphone. All the seniors are over 65 years old and these nine people from Turkey.

3.1 GAME CONTENT

Serious game named GeceKusu is specially developed for the elderly people for android mobile phones. According to Flores et al. (2008) motivation to play games must be provide cognitive challenge, easy goals, simple interface and rewarding. This game is a simple platform game with single goal where we manage a bird at the right time pushing the screen we go through without damaging the pipes. Resene (Atkinson 2004), color and paint technology company has published an article about using the right colors for the elderly. According to that, soft tones of reds and oranges warm up and can help circulation and energy levels. At the same time soft blues, lavender mauves and violets are colors that connect to the spiritual or reflective mood. So, the colors of the game are set to these tones. Fonts and bird size were significantly enlarged. Designed to be easy to use and it will not take much time to get used to. There is no level of difficulty in the game to prevent panic, users can improve their scores as much as they want. Game is developed with Unity platform in C# programming language. It can run on smartphones, tablets and PCs that have installed the version 6.0 or higher operating system. This platform game was entirely intended to help seniors see the effects on their cognitive skills and to have a good time. The game mechanics is easy to understand and good visually will to be a good motivation source for them. It is quite easy for the elderly to start the game as seen in the Figure 3.1. Users will be able to see the highest scores they get.

Figure 3.1: GeceKusu game main menu

The main menu of the game has been developed for the memorability and usability of the elderly. Also, this game requires no internet connection, elderly users can play the game on their own. Game language is completely Turkish.

Figure 3.2: GeceKusu gameplay

The developed game is a simple platform game that requires a lot of skill such as divided attention, hand-eye coordination, response time, focus, decision making, quick reflexes and environmental control. The icons have been enlarged to fit the elderly and the distance between the pipes has been opened, as shown in Figure 3.2.

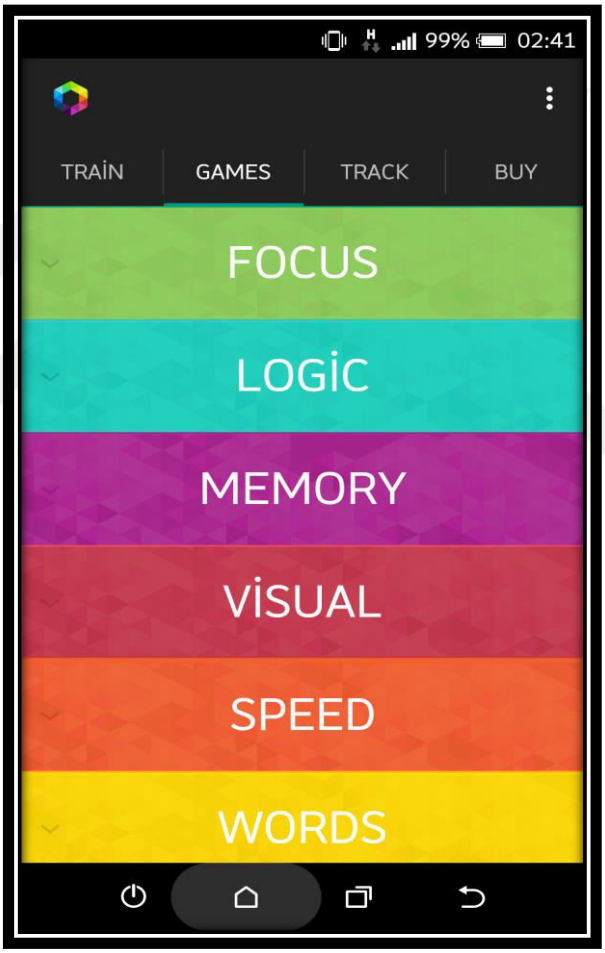
So, this game has been developed to be easy to learn, difficult to master. When a platform-based mobile game developed to fit the needs of the elderly, it was hypothesized that they will improve their cognitive skills in a shorter time. Also, suggested that successful performances in the GeceKusu game would be directly proportional to the high scores made in the cognitive measures.

3.2 SKILLS TO BE MEASURED

There are some important companies that implement applications for measuring and developing mind exercise. Some of the most important ones accepted by the literature are

Fit Brains, Lumosity, CogniFit and Peak. There is a study comparing these applications (Avriel et al., 2017) according to this research result each application has its plus and minus aspects. FitBrains named mobile serious game application was chosen to measure the cognitive skills needed to succeed in the GeceKusu game. The reasons for choosing this application is that it is visually optimal and easy to learn for the elderly.

Figure 3.3: FitBrains application games main menu



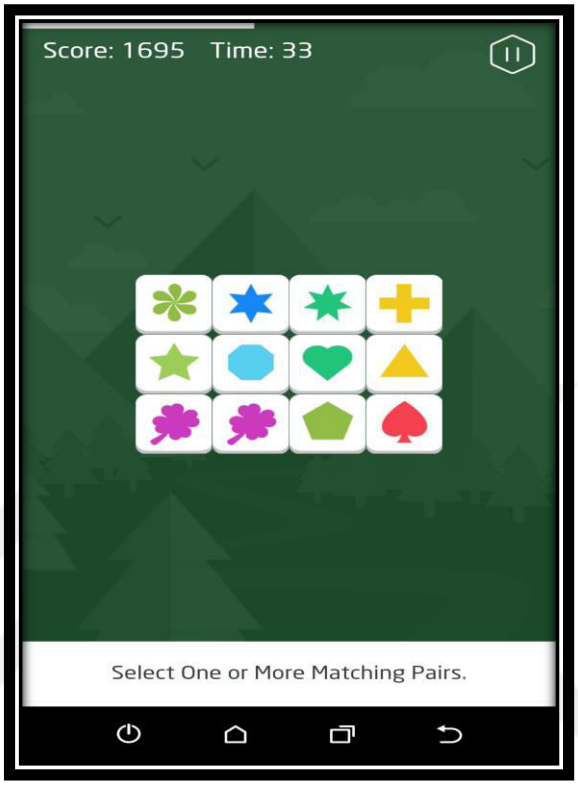
Main headings are grouped as Focus, Logic, Visual and Speed. Memory and Words categories are not used because they are not linked to the GeceKusu game (Figure 3.3). "The success achieved in these talents is directly related to being successful in the game" proposal will be answered. The time spent in this game will be observed on the effects of these skills. There are more games available free of charge than any other application and there are three levels of difficulty for each game. The easiest difficulty level was selected

for measurement. There is not a necessary criterion except that the elderly selected are older than 65 years. Each subject will be asked questions such as level of education, age, experience with the cell phone or computer. Will also be notified if there is a serious health problem that may occur while playing. Since the game is easy to learn, only the rules will be briefly explained to subjects. These games will provide a very important motivation to be played without getting help. Breaking prejudices and fears is very important to this issue. The more successful ones will be monitored with the help of previously asked questions. The effects of features such as smartphone use, previous gaming experience, ideas about games or level of education will be seen.

3.2.1 Measurement of Cognitive Skills with Mobile Serious Games

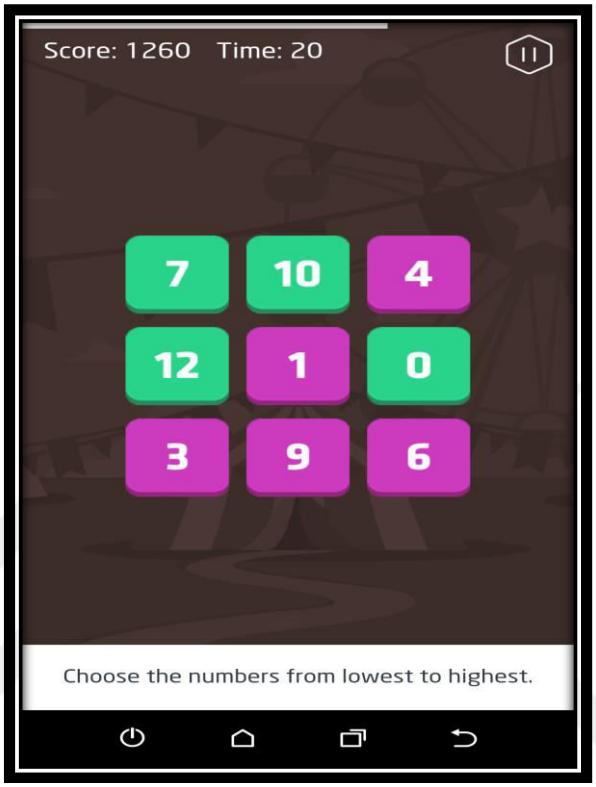
The achievement evaluation obtained in FitBrains application is measured according to criteria such as reaction time, accuracy, error making situation, correct use of time. The subjects will see their performances after playing the game. Percentage success, score and able the see his/her performance compare with others. The evaluation period for all games is one minute. All selected games are free under the FitBrains application and there are three levels of difficulty for each if success is achieved. Application can be downloaded for free from Google Play. Besides of the that selected games rest of the games are charged. Turkish language support is not available. All interfaces in the application are English and internet connection is required. The games in the application are suitable for the elderly, but it is difficult for the elderly to find and choose the games without getting help in the main menu. Cognitive skills are very important because they allow us to be more productive in our everyday lives.

Figure 3.4: Match pairs game (Focus)



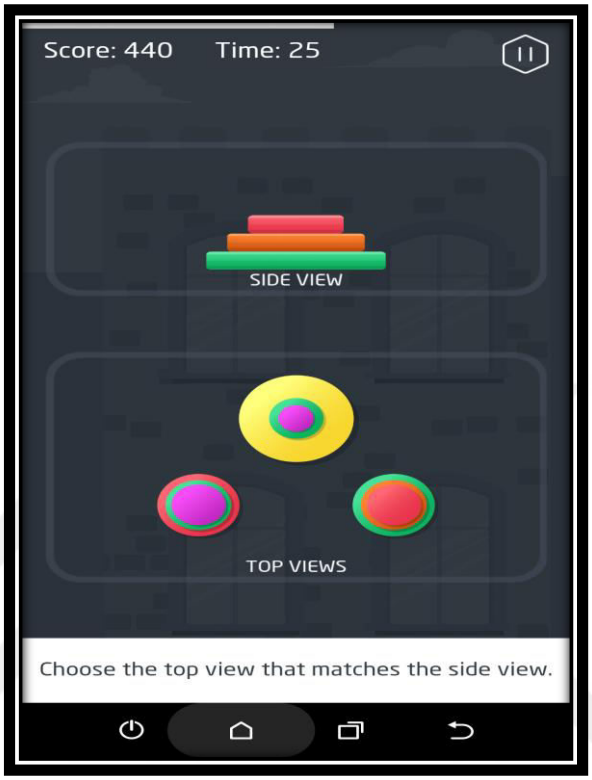
Elderly subjects firstly play the matching pairs game under the title of Focus when playing FitBrains (Figure 3.4), what is important here players must select the same objects as quickly and carefully as possible. Because of types, colors and locations of the shapes are variable in each new game, participants have no opportunity to try to memorize the places of objects and gain advantage. It is quite easy for the elderly to learn and play this game. The interface of the game, size of fonts and background colors are suitable for seniors. Focused attention is the ability to concentrate the attention of the brain on a stimulant for a long time. This ability depends on personal factors, environmental factors and stimulant factors.

Figure 3.5: Sort numbers game (Logic)



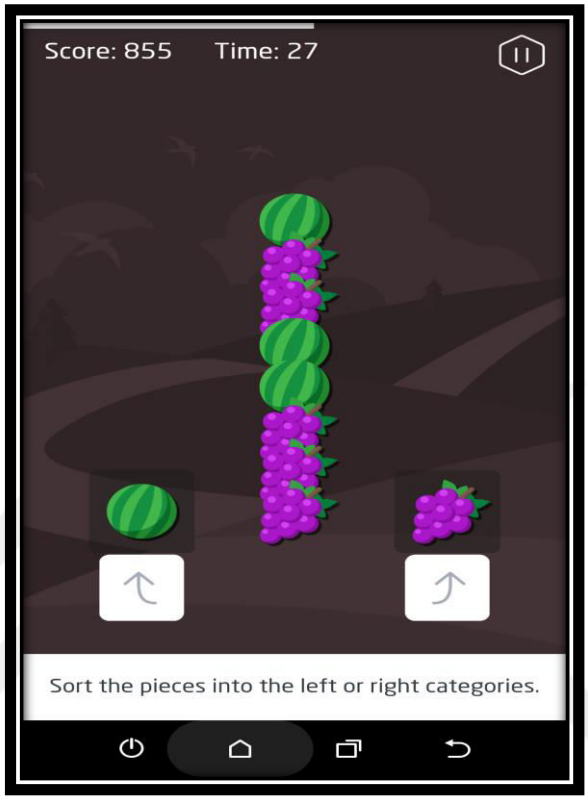
Then under the Logic heading elderly people will try to choose the numbers from lowest to highest (Figure 3.5). Basic mathematical knowledge is required to play this game. The numbers in this game appear as irregularly and randomly. The mental processes used in planning such as creating goals, making plans can be implemented and developed with cognitive stimulation and a healthy lifestyle. Divided attention is a concurrent attention that allows us to manipulate different sources of information and accomplish many tasks successfully in a single time. Consequently, quick thinking, planning, divided attention and reaction time are qualities that are necessary to succeed in this game.

Figure 3.6: Stacked discs game (Visual)



After that under the Visual title, users will choose the top view that matches the side view (Figure 3.6), in this game users should sort the colors correctly from the bottom upwards. In this game the participants' ability to interpret visual perception, i.e. knowledge of the effects of visible light reaching the eye are measured. Additionally, the ability to visual scanning is important to be successful in this game. Visual scanning is the ability to search for relevant information in a fast, accurate, and efficient way. This capability includes selective and focused attention, visual perception and recognition. Visual scanning is an important skill for everyday life, and it allows us to do many different things correctly thanks to this ability.

Figure 3.7: Proper sort game (Speed)



And lastly the Speed heading this part is about clicking left or right sort objects as quickly as possible (Figure 3.7). In this game the ability to processing speed and response time were measured. The processing speed is a cognitive ability that can be defined as the time a person uses to perform a mental task. It is related to the speed of understanding and reacting to the information someone has received. Reaction time or response time expresses the amount of time that elapses between the time when we react to something and the time when we perceive something. It is the ability to recognize a warner, process it, and then respond to it. This has been their most challenging game due to their ages, because this game is completely based on speed. The slow response times of elderly people and the lack of experience their performance success rates were low.

Current evidence suggests that the brain is a flexible and renewable organ and that it can maintain or even improve its current level of performance when it is aged, particularly when it is driven by an active and mentally stimulating lifestyle. It's a good thing that some

of the tasks like bike riding are automated over time. This allows our brain to direct attention to other things. But it also creates some problems in the long run because our brain's tendency to create routines that facilitate experiential learning and day-to-day computing encourages laziness and relaxation. As you get older, this problem gets bigger because it becomes harder to learn new activities that will force your brain. Therefore, brain fitness is extremely important.

Since the developed GeceKusu mobile game is a platform-based game, it is covering all of the above-mentioned talents. Thence, it was predicted that users could perform their mental activities in a shorter time.

3.3 GAME SELECTION EXPERIENCES

Based on the statement of Nap et al. (2009) that seniors prefer serious casual games with mental exercises. GeceKusu game and other serious games used for measurement were selected according to this result. Mental exercises include very important aspects such as reasoning, awareness, perception and intuition. They are indispensable cognitive skills for a strong brain health. Another significant aspect of the selected games was their usability and motivational factors. Prevent usability problems in evaluating the motivation factors of games is the focus of this work. These features were determined from the literature review.

According to the findings of Ilsselsteijn et al. (2008), one of the most widely accepted evaluation in the literature; players' gaming experience was measured by asking participants to fill in the In-Game Experience Questionnaire (iGEQ). The iGEQ includes 14 items evaluated at a five-point intensity scale, distributed in pairs between following seven dimension of player experience: a) Immersion, b) Flow, c) Competence, d) Tension, e) Challenge, f) Negative affect and g) Positive affect. When you play the game for each item, it shows how you feel on the following scale Ilsselsteijn et al. (2013):

not at all	slightly	moderately	fairly	extremely
0	1	2	3	4
< >	< >	< >	< >	< >

i) I was interested in the game's story.

ii) I felt successful.

iii) I felt bored.

iv) I found it impressive.

v) I forgot everything around me.

vi) I felt frustrated.

vii) I found it tiresome.

viii) I felt irritable.

ix) I felt skillful.

x) I felt completely absorbed.

xi) I felt content.

xii) I felt challenged.

xiii) I had to put a lot of effort into it.

xiv) I felt good.

Component scores are calculated as the average value of their items. **Immersion:** Items i and iv, **Flow:** Items v and x, **Competence:** Items ii and ix, **Tension:** Items vi and viii, **Challenge**: Items xii and xiii, **Negative affect**: Items iii and vii and **Positive affect**: Items xi and xiv. The IGEQ is a shorter and more reliable in-game version of the Gaming Experience Questionnaire (GEQ) and has been selected so that participants will not be exhausted. These questions were asked separately for five games.

3.4 DATA COLLECT

Data collection was done by asking questions and observing. It is important that elderly people have a fun time playing games and motivate them to play again. When they make mistakes their reactions and how to get rid of the errors will be monitored. It is expected that seniors will be able to adapt more easily to games on mobile phone. Additionally, it is important not to tire or pressure the old players. The effects on skills focus, logic, visual, speed will be observed in the platform game developed for the elderly. The selected games are equal conditions for everyone because there are no factors such as task/chapter repetition and in this case, it will be more accurate to solve the learning effect.

The subjects who will play the games were asked four questions before games. These questions were directed in order to have information about the profiles of users, these questions are:

i) What is your gender, age, education status and occupation? (completed primary, completed secondary, completed tertiary)
ii) Are you using smartphone, if yes for what purpose? Have you ever played a digital game before? (frequency of use “never”, “rarely”, “most days”, “daily”)
iii) Do you find games useful or harmful? Why?
iv) How important is technology in your life? (“never”, “rarely”, “most days”, “daily”) What is your experience with technology? (devices they own and use)

After asking questions, the candidates were played all the games on the Android smartphone meanwhile they received instructions on how to play the games. Their errors, speeds and performances they made in the FitBrains application games analyzed. Contents of games are discussed in Section 3.1 and Section 3.2. Firstly, the measurement was made, then the GeceKusu game was played to the old peoples for 25-30 minutes for three days and the last remeasurement was done, the results are compared. The candidates played for a total of 3 sessions, 3-4 hours for 1 week. To quantify the participants' gaming experience, the in-Game Experience Survey (iGEQ) was applied immediately after 5 games they played for the first time. The decrease of faults they made, the increase in speed and the improve of attention will be expected. After the games, open questionnaires were asked. These six survey questions are:

i) Did you have fun while playing games? Would you like to play again?
ii) Would you recommend playing games to the others?
iii) Did you have any difficulties while playing games? If yes what was it?
iv) What was your favorite game?
v) Can you say that you can adapt better when playing on the smartphone? Do you think if you played on a computer your performance might be different?
vi) Did these games change your approach to the technology or digital games? Would you like to add another suggestion?

Asking questions before and after is important to understand how the elderly are approaching games or mobile devices for measures. The following factors were sorted in order to understand who was more successful when playing games; educational status, gender, cell phone or smartphone use, job, age, how they approach at games and technology. Each participant was asked a total of 80 questions for each of them, including before playing the games questions about learning general features, evaluating games, and final opinions.

3.5 COGNITIVE SKILLS AND OTHER BRAIN TRAINING FINDINGS

Researchers at King's College London (Corbett, et al., 2015) have discovered that mental exercises or brain training can improve people's daily lives. According to this research, cognitive education can help in tasks such as public transportation, shopping, cooking, and financial management. Approximately 7,000 people over the age of 50 were recruited from the public through the BBC, the Alzheimer's Society and the Medical Research Council to take part in a six-month trial. Six months later, 60-year-olds who participated in brain training found significant improvement in their daily tasks. A previous study by the same researchers suggested that such exercises do not benefit the younger than 50 years.

According to another study with elderly, the Smartkuber game showed high validity and predictive versus the MoCa test on cognitive health screening of the seniors (Boletsis & Mccallum, 2016). The Montreal Cognitive Assessment (MoCA) is designed as a rapid screening tool for mild cognitive impairment. This tool evaluates different cognitive domains: attention and concentration, executive functions, memory, language, visual structure skills, conceptual thinking, calculations and orientation. The study follows a mixed methodological approach to examine the relationship between Smartkuber and MoCA scores using the in-Game Experience Questionnaire to assess the players' gaming experience and correlational work. The study was conducted with 13 elderly adults for 2 months. As a result, this game is a promising tool for cognitive health screening, offering a fun and motivating gaming experience for older players.

In this study, the relationship between FitBrains and platform game GeceKusu was examined, similar to the above method. In summary, the effects of mobile platform games on focus, logic, visual and speed cognitive abilities of elderly people will be examined.

4. FINDINGS

IBM Statistical Package for Social Sciences (SPSS) version 25 was used for the analysis of data. The "GK score" created to measure elder's performances, it was calculated by the average of the three highest scores made in the GeceKusu game. FitBrains scores were obtained from games in the focus, logic, visual and speed subtitles names, average of their success rankings (%), scores and errors they made. "Cognitive score" name was used to define these collected data. Significance level was set at $p < 0.05$. The Pearson correlation coefficient was used to measure the linear relationship between GK score and FitBrains score. The paired samples T test was used to compare the mean total scores of the first and last game performances of the cognitive abilities of the players. Cronbach Alpha coefficient was used to evaluate internal consistency.

4.1 PROPERTIES OF THE PARTICIPANTS

A total of 9 people participated in the study of correlations and gaming experiences. The participant group was selected completely random, no specific criteria required so, there are no common points except for the condition to be over 65 years old. This group consisted of five women and four men. The average age of the group was 67.8 years. The youngest participant in the selected group was 66 years old and the oldest was 74 years old.

Four participants graduated from college. Two of them finished high school and the remaining three only primary school graduates. Among the participants were two retired teachers, one teacher, a retired public worker, public relations, commerce, housewife, doorman and interior designer. No candidate had a serious health problem except that some of the candidates were hypermetropia.

Four of them were smartphones and three of them were cell phone users, the remaining two were not using anything. Mobile phone users were just using them for speech or message writing. None of the candidates have ever played game before, except for one person who says play very rarely, no one knew how to use a computer. They viewed digital games as both useful and harmful as a majority. Some of them express concerns about their children

or grandchildren spend a lot of time in games and violent games. But they all agreed that games are useful if used properly except for the teacher who said the games were harmful.

4.2 MOTIVATIONAL FACTORS AND CONCERNS FOR GAMES

Playing the games on the smartphone became a motivation source for all the participants. The elderly people said they did not play any games on their mobile phones because they found it difficult. Before they start play games, most of them are afraid that they will not succeed or can't make it. After very brief description, they easily understood the mechanics of games that fit the needs of the aged. Some internal and external factors can affect the success of a user when performing an activity. Each candidate was totally entertained while playing games, striving to improve himself when he/she failed. All the candidates made very few mistakes, but they were very slow. They did not worry that I was unsuccessful, they talked about their inexperience. None of them thought they could be more successful on a computer or other consoles. There has not been a decline in self-esteem.

The person who said the games were harmful partly changed her mind, the rest said that the games were fun, beneficial for mind and reduce their stress. There was no specific link between those who were more successful or those who were not. Games that stimulate competition motivate older players. They love vivid colors and prefer to play games with audio. These were the factors that encouraged them to play. Two people who did not use a mobile phone were not disturbed by the lowest scores and the least amused ones.

All the candidates liked all the games, the GeceKusu and "fruity" proper speed sort game was the most liked, which these were the games they failed the most. They did not care to be successful, the usability and vibrant colors were the motivation source for them. All the seniors said to recommend it to others. Seniors said that they did not have any difficulties other than their inexperience. The elderly has remarkably changed their attitudes towards technology and digital games in a positive sense.

4.3 STATISTICAL ANALYSIS

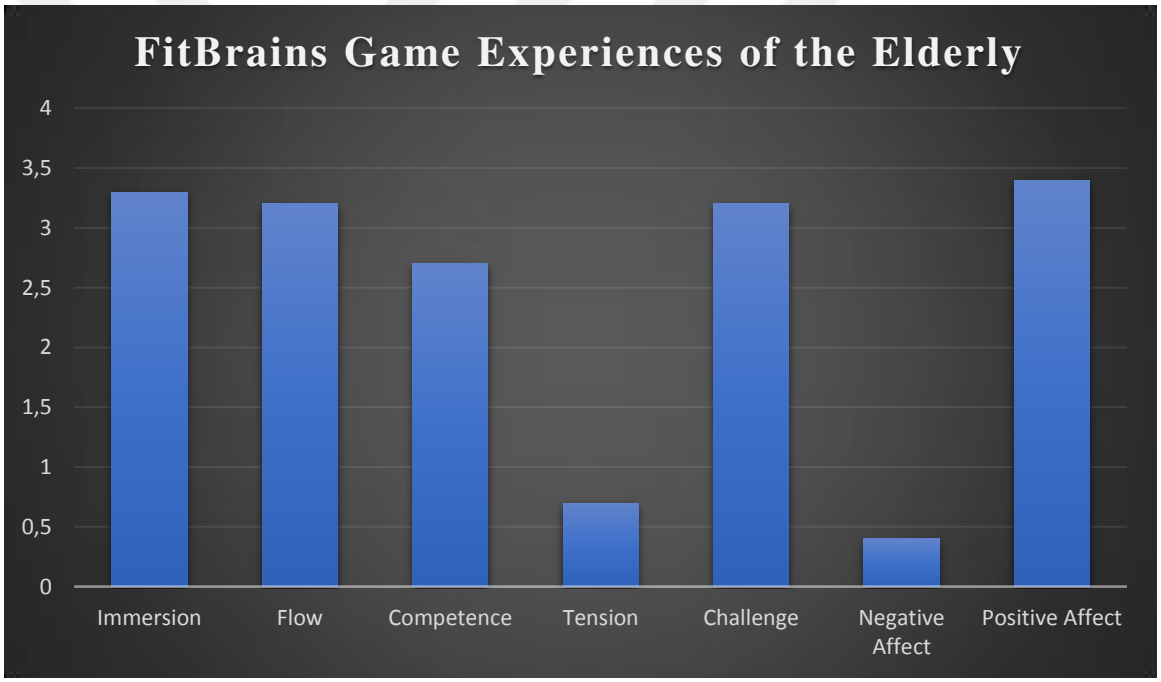
All collected data was analyzed to ensure satisfaction of the ages of serious mobile games and to define the items that must be motivated to play them. This section presents the

results obtained.

4.3.1 Elderly Participants' Reviews of Games

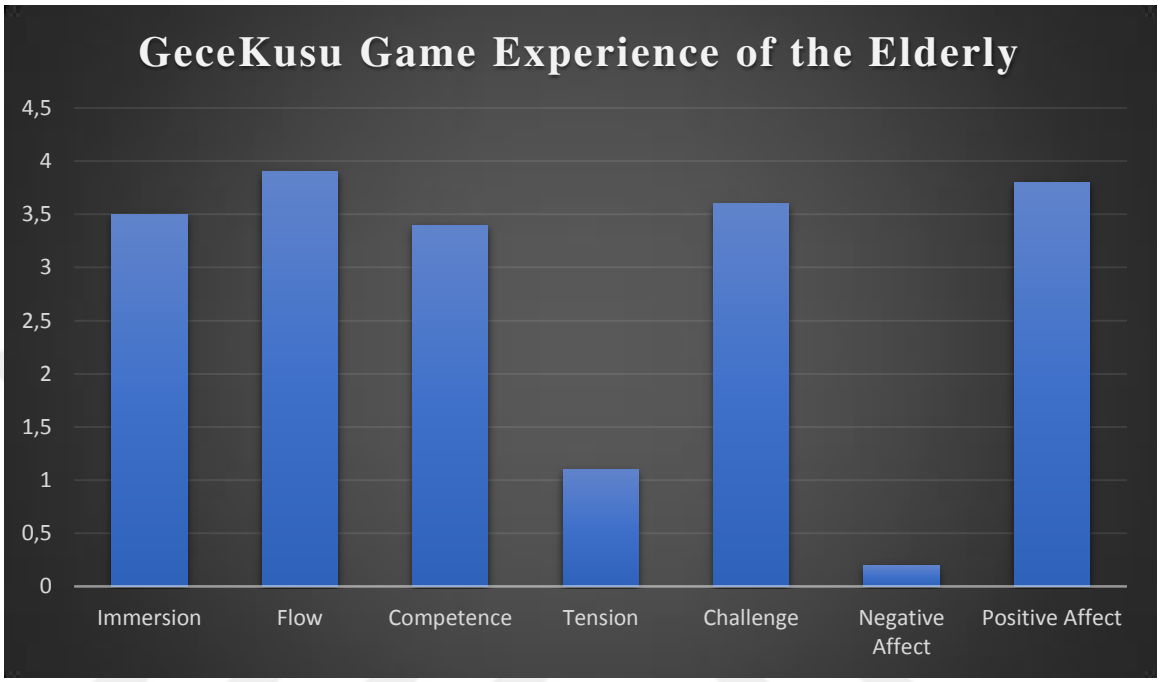
All candidates completed the iGEQ questionnaire for five games. Figure 4.1 show that Positive Affect, Immersion, Flow and Challenge displaying high values, Challenge shows average value, and Tension and Negative Affect low values. The lowest standard deviation was Competence (SD: 0.03), the highest standard deviation was Flow (SD: 0.28).

Figure 4.1: The iGEQ mean scores in seven dimensions of gaming experiences, for the total average of four FitBrains application games



As seen in Figure 4.2 it has been observed the values that should be high were high and the values that should be low were low. The success rate is higher than the average of other games except Tension. None of the attendants had strain keeping the phone, but those who did not use a smartphone were a bit difficult to touch the screen. The elderly did not have visually complications, they easily got into game mechanics. Participants did not mention any difficulties, they were completely focused on the games.

Figure 4.2: The iGEQ mean scores in seven dimensions of gaming experience, for the GeceKusu game



In time-based games the candidates do not understand how time passes, in the GeceKusu game they want to start again immediately and improve their scores. All the elders seemed very happy while play the games, they were all motivated. Many of them said they understood why their grandchildren played game constantly, also said we wanted to play with them. They seemed to have overcome their failures and prejudices. After all games, the most remarkable answers among participating elders are listed below.

Participant 1 was a 65-year-old retired teacher, used the smartphone for speech only. She said that I was enjoying while playing and wanted to play again, recommend to others, the difficulty she faces is the slowness and inexperience, her favorite games were GeceKusu and like she said “fruity” speed sort game, also she said I adapted better with the mobile phone, I would have been more unsuccessful if I were on the computer and lastly, she said these games have changed my opinion on technology better way. The best scores in the games belonged to her.

Participant 2 was a high school graduate public worker at the age of 65, he said he did not

use cell phone and never played game before. It took some time to get used to the touchscreen due to the strangeness of the mobile phones, and that was the issue that forced him the most. But he said it was much easier to get used to games, he had fun playing and wanted to play again. His favorite game was GeceKusu, although not very successful in the games, this did not prevent him from having fun. The lowest scores in the games belonged to him.

Participant 3 was 67 years old, used the smartphone just to talk. She said she used the technology most of the time, but she found the games to be harmful. As a justification for finding harmful, showed that their students are constantly dealing with mobile phones and she considers it a waste of time. After playing games, she told that she had fun, recommend to others, and had no difficulties other than inexperience. She said that his favorite game was GeceKusu and her idea was partly changed when she learned that there were such useful games.

Participant 4 was a retired teacher at the age of 66. She used her smartphone to talk and rarely use it for messaging. She said that she used the technology most of the time and that the games were useful and harmful side. Said that she had a lot of fun while playing, that she wanted to play again and suggest it to others. She said it was GeceKusu game because it was easy and the speed sort game (like she said “pearly game”) because of the colors of her favorite games. Finally, she stated that games are useful for intelligence. The scores she gains in games were above the general average.

Participant 5 was 66 years old abandon high school and dealing with public relations. Most of the time she was using her smartphone for speech and messaging purposes. She has never played game before, and she has a partly positive opinion about the games. She explained that she saw the games in the hand of her grandkids and was afraid she would not make it. But she easily understood the mechanics of the games, said she had a lot of fun playing and understood why her grandkids played so much. Her favorite games were GeceKusu and like she said “cherry” speed sort game. Lastly, she said that the games were enjoyable and overcome her fear.

All of the participants said they prefer mobile phones instead of computers to play games. They expressed that they chose plenty of vivid colors and non-violent games, visual appeal as it was one of the most important factors for them.

4.3.2 Performance Analysis of the Elderly

Main demographic characteristics of the participants are presented in Table 4.1. The effect of the platform-based game on the cognitive abilities of the elderly has been explained.

Table 4.1: Demographic features and first FitBrains scores

Demographics		**n = 9**
Age		67.8 (2.91)
Gender (M/F)		4/5
Education level as %		
Completed primary		33.3 (n = 3)
Completed secondary		22.2 (n = 2)
Completed tertiary		44.4 (n = 4)
Technology usage frequency as %		
Never		0
Rarely		44.4 (n = 4)
Most days		44.4 (n = 4)
Daily		11.1 (n = 1)
Playing digital games usage frequency as %		
Never		88.9 (n = 8)
Rarely		11,1 (n = 1)
Most days		0
Daily		0
FitBrains	**Success Ranking (%)**	**Accuracy (%)**
Focus	17.75 (9.57)	83.4
Logic	13 (5.78)	89.8
Visual	14.66 (5.87)	88.8
Speed	7.11 (6.50)	95.4
Before GeceKusu game total score of rank		52.52 (4.47)

Age, FitBrains, and GeceKusu scores and properties are given as the average, brackets represent the standard deviation for Table 4.1 and Table 4.2.

Table 4.2: GeceKusu performances and last FitBrains scores

GeceKusu game		**GK score**
Participant #1		29.33
Participant #2		14
Participant #3		16.66
Participant #4		17.33
Participant #5		18.33
Participant #6		21
Participant #7		15.33
Participant #8		20
Participant #9		25.66
GeceKusu game total		19.73 (4.97)
FitBrains	**Success Ranking (%)**	**Accuracy (%)**
Focus	24.88 (13.15)	82.6
Logic	16.44 (8.61)	91.2
Visual	20.55 (10.36)	89.4
Speed	9.88 (7.92)	94.6
After GeceKusu game total score of rank		71.75 (6.38)

All participant plays the games for a total of three sessions during a week. It was understood that the most advanced cognitive skills of the elderly were focus, visual, logic and speed respectively. Even in such a short time an increase was observed in all the investigated abilities of elderly participants. There was no correlation between accuracy. GeceKusu game scores showed a high level of internal consistency (Cronsbach's alpha = 0.758 and Cronsbach's alpha based on standardized items = 0.824).

According to the analyzed data, women were more successful. The game performances of the smartphone users and high technology use frequency have made a big difference compared to those who do not use phones or those who use regular mobile phones. Those with completed tertiary were found to be more successful. It has not been a significant influence of their age and professions. No information was available on this subject since none of the participants had previous gaming experiences.

Pearson correlation sig. (2-tailed) study between first GK score and first score of focus, logic, visual, and speed revealed this relationship. According to this data, as follows ($p < 0.05$); focus ($\alpha = 0.645$, $p = 0.61$), speed ($\alpha = 0.634$, $p = 0.66$), logic ($\alpha = 0.485$, $p = 0.186$), visual ($\alpha = 0.475$, $p = 0.196$). Focus and speed revealed high and meaningful relationship with reference to this, first time players who were successful in platform-based games were also successful in focus and speed.

Pearson correlation sig. (1-tailed) study between last GK score and last score of focus, logic, visual, and speed revealed this relationship. According to this data, as follows ($p < 0.05$); focus ($\alpha = 0.537$, $p = 0.68$), logic ($\alpha = 0.320$, $p = 0.200$), visual ($\alpha = 0.687$, $p = 0.20$), speed ($\alpha = 0.376$, $p = 0.159$). Visual and focus revealed a positive meaningful relationship according to this, increased scores in the GeceKusu game also increased the scores visual and in focus. However, no strong linear statistical relationship was found for the remainder.

Table 4.3: Correlation between the GeceKusu game and Fitbrains scores

FitBrains	**GeceKusu**
Focus Performance	0.55**
Logic Performance	0.68
Visual Performance	0.41*
Speed Performance	0,66**

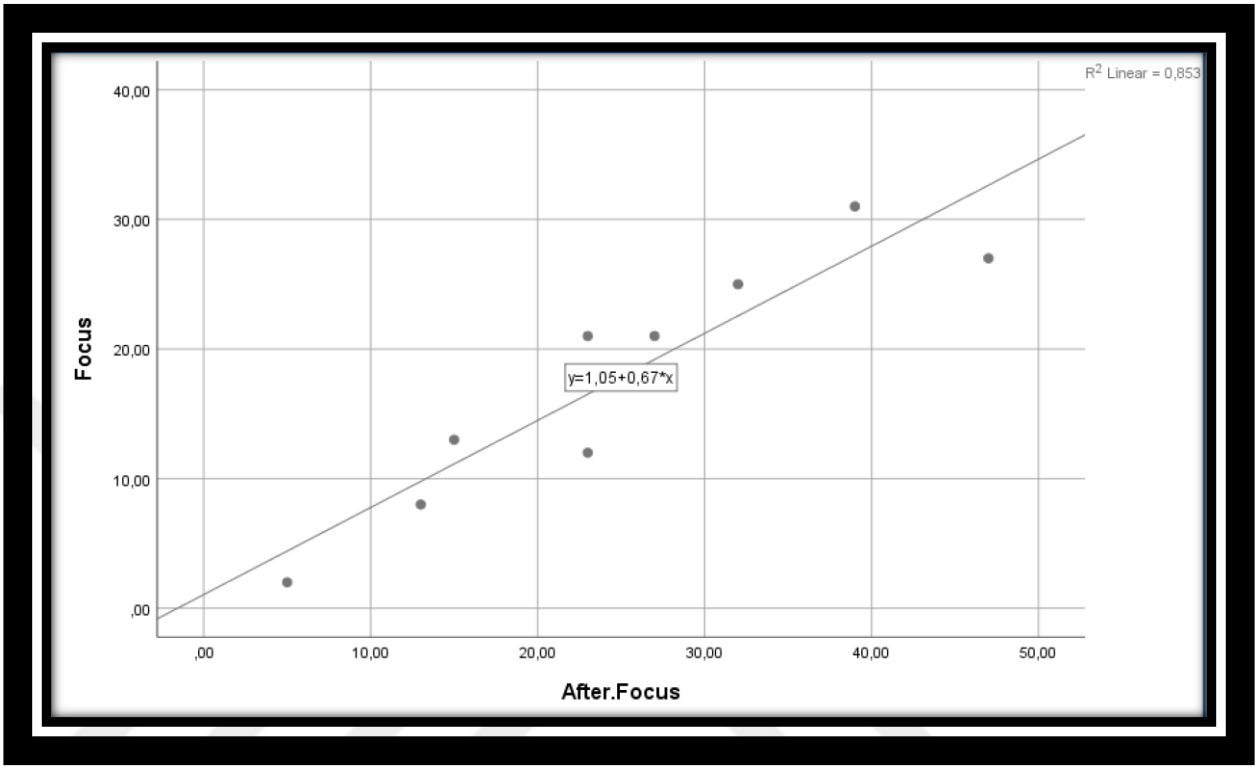
*$p < 0.05$; **$p < 0.01$

The correlation between the GeceKusu mean total scores (GK score) and FitBrains scores (Cognitive score) is shown in Table 4.2. This study has shown that platform-based mobile

games have a high and significant correlation over focus, visual and speed. It was found to have a positive effect on all cognitive abilities investigated ($r[9] = 0.61$, $p = 0.05$).

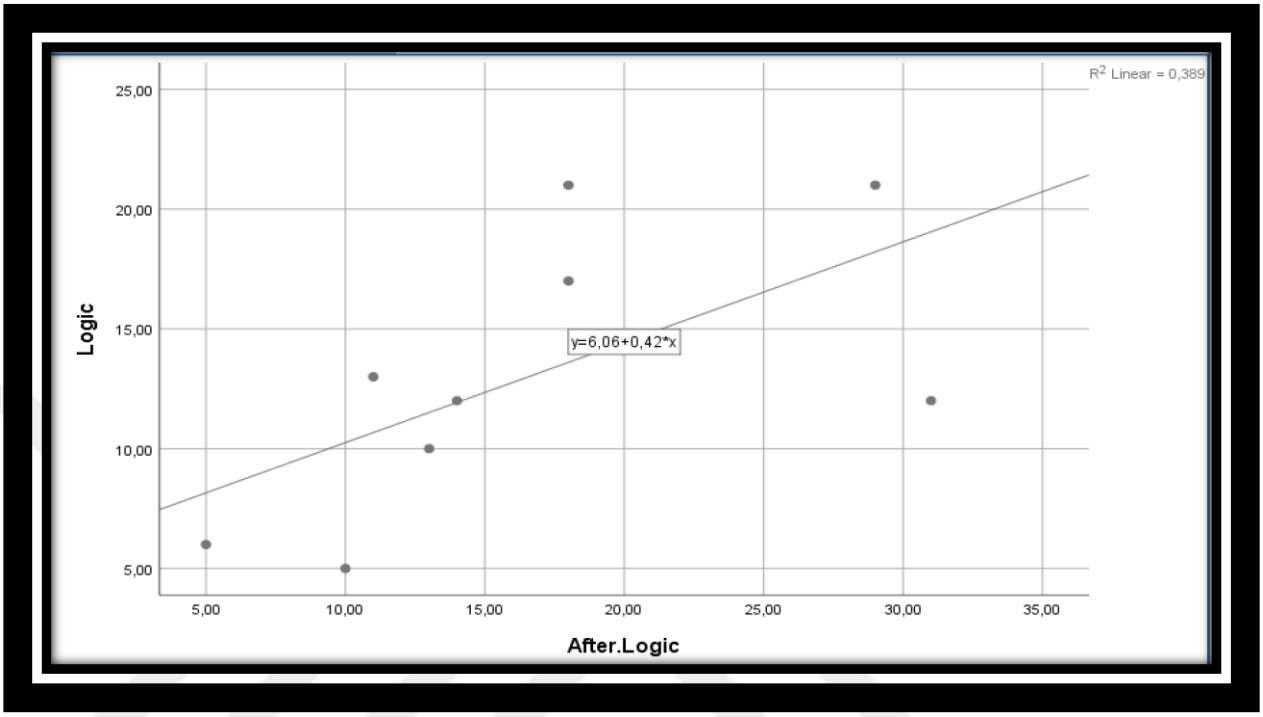
GeceKusu game was a significant determinant of mean total scores and explained the 59.3% variance of FitBrains total scores.

Figure 4.3: Before and after focus scores of the participants



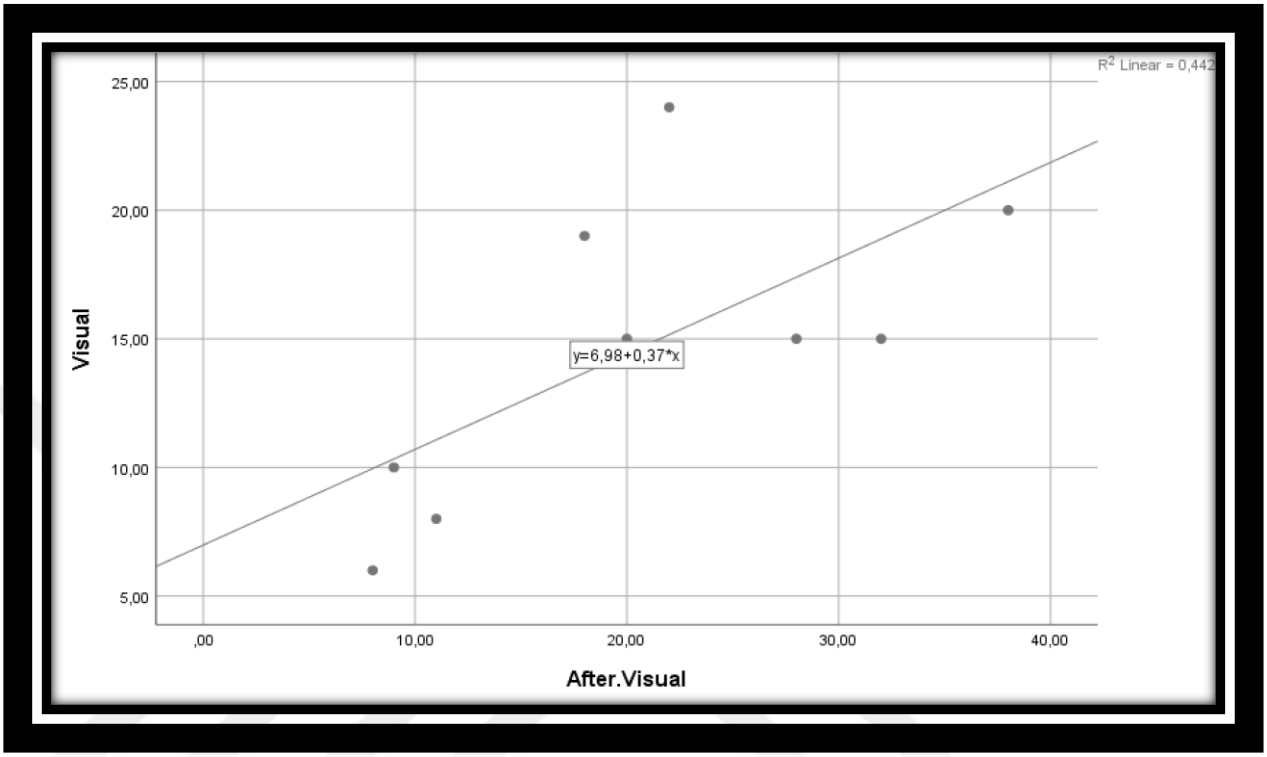
Scatter plot Figure 4.3 shows that first and last focus scores of the participants. In this graph, the two variable values are increased at the same time and the points are clustered near the line, so it is understood that there is a strong positive correlation between the two values. It can be said that platform games are an important influence on the focus. The success rates of participants are close to each other.

Figure 4.4: Before and after logic scores of the participants



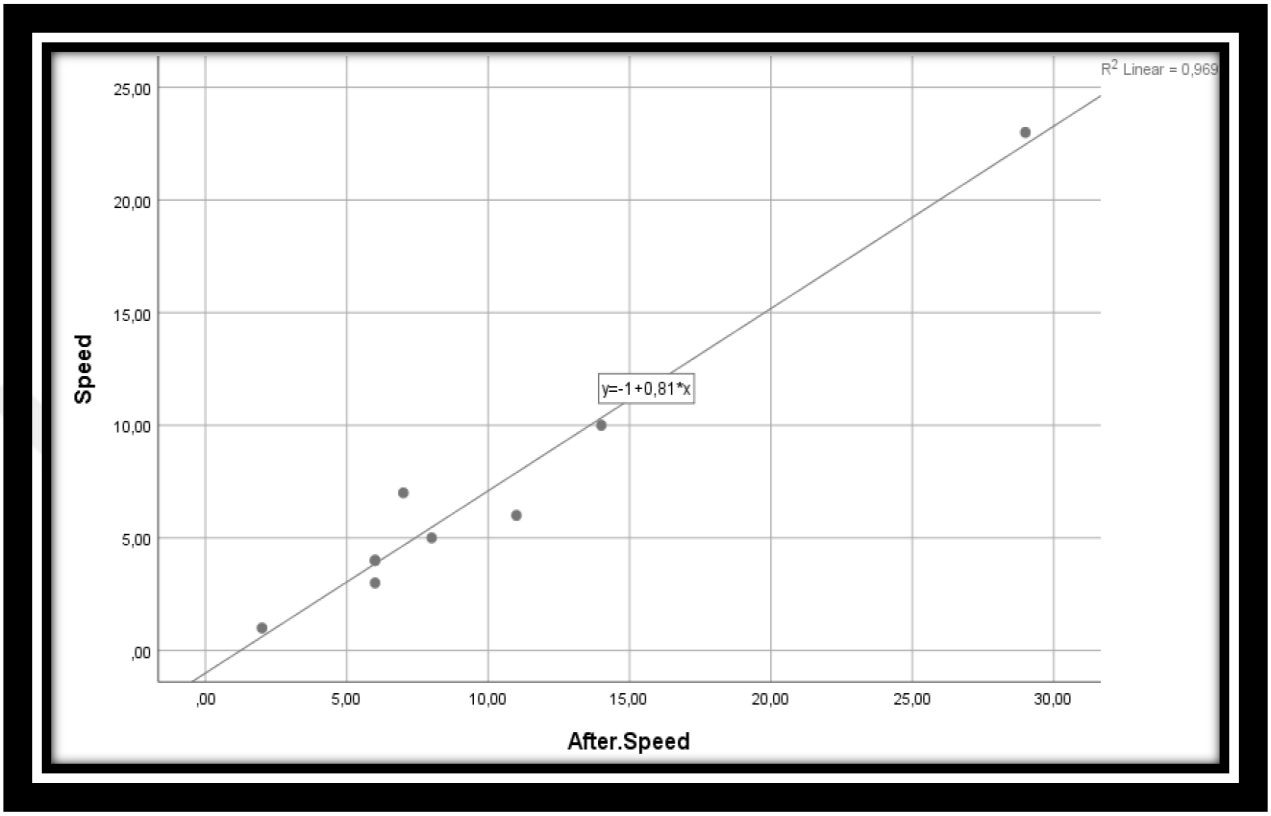
Scatter plot Figure 4.4 shows that first and last logic scores of the participants. The values of the two variables in this graph have increased by the same amount but it is observed that the points are scattered. According to this data, there is a weak positive relationship between participants' logic scores. It can be said that platform games have a positive effect on logic although not very important.

Figure 4.5: Before and after visual scores of the participants



Scatter plot Figure 4.5 shows that first and last visual scores of the participants. Similar to the logic in this graph, the values of the two variables increased by the same amount, but it was observed that the points were scattered. It can be said that despite the weak positive relationship, the participants were slightly more successful than the logic performance.

Figure 4.6: Before and after speed scores of the participants



Scatter plot Figure 4.7 shows that first and last speed scores of the participants. Similar to the focus in this graph, the two variable values are increased at the same time and the points are clustered near the line, so it is understood that there is a strong positive correlation between the two values. Platform game have been found to have a significant impact on the speed capabilities of the elderly.

As shown in Figures 4.3, 4.4, 4.5, and 4.6, GeceKusu game has a positive effect on all cognitive abilities. Speed is their most failing title, according to elderly's lowest scores. It is noteworthy that the presented percentage of success cognitive scores result is aimed at all people, not only the elderly. However, age limitations must be considered when developing games for the elderly.

5. DISCUSSION

5.1 GAME EXPERIENCE OF THE ELDERLY

GeceKusu and FitBrains games provided important feedback on gaming experience. All the games selected in the FitBrains were chosen to fit the needs of the elderly and therefore none of the participants had a difficult time when playing. Participants who did not use a mobile phone hesitated a bit in the beginning, but the games started to attract and entertain themselves. The most important motivation in this was that the elderly could play on their own without getting help. Flow and Immersion elements are of great importance for assessing the cognitive stimuli presented by games because they try to measure the subjective experience of the player participation and play cognitive participation. Both of these elements showed high values with GeceKusu, which showed high level cognitive participation of the players. The high level of Competence reveals that players feel competent enough playing GeceKusu, with the significantly high Challenge value, participants were more concentrated to be more successful. Lastly, the high value of the Positive Affect and the low values of the Tension and Negative Affect showed the amusing and motivating nature of the GeceKusu, the suitability of the user interface, and the positive interactions of older players. At the same time FitBrains games have given similar results and are suitable for the elderly. The common sense of the elderly was that the games were fun and educative if used correctly.

5.2 MOTIVATIONAL FACTORS

Motivational factors that encourage seniors to play serious games on smartphones have given effective results. All of the elderly participants said they would recommend it to others and want to play again. The GameFlow model worked well without any problems. According to many researches, usability has been understood to be the main factor that causes a game to be accepted by the user, and this study supports this result. The elderly participants easily learned the logic and mechanics of the games on the mobile phone and the self-esteem was preserved. Although their performances are not very good in the

games, the seniors explain this with their inexperience, which explains that the aim is achieved. Seniors become easier to adapt to games on mobile phones. By playing games, seniors can join more into society, give meaning to the day with enjoyable pass time, succeed aging and reduce technological exclusion.

5.3 STUDY OF CORRELATION

Correlational study showed a positive relationship between platform-based games and the cognitive abilities of the elderly. While the GK score showed a high internal consistency value both completely and individually, it showed a significant correlation with Cognitive score. Even if there were no successes in the GeceKusu, it was determined that the cognitive abilities of the elderly improved by spending time with this game.

The results of the regression show that GeceKusu total scores were significantly predictive after setting the demographic characteristics of FitBrains total scores. Because of the this and above reasons, platform-based mobile games have a positive effect on cognitive abilities. The proposed hypothesis has been successful on a very large scale.

5.4 SCOPE LIMITATIONS

This study was limited to a small data set. Increasing the number of participants and cognitive abilities examined may be effective for more accurate results, gameplay time can be longer-term. Cognitive abilities have been studied as main topics, but these main topics have their own sub-titles such as, divided attention, hand-eye coordination, inhibition, response time and estimation. Learning effect is an important issue to be considered as it is not a participant with gaming experience. The FitBrains test has not been proven to be completely reliable, also it should be noted that external factors also affect performance and success rates of elderly participants are valid for all age groups, the success rates within their age groups are not understood. Therewithal, because the language of the application is English, the participants could not play without getting help until get used to it and they could not figure out the results.

6. CONCLUSION AND RECOMMENDATIONS

GeceKusu and other mobile games, entirely have succeeded in offering a fun, attractive and motivating gaming experience to senior players. To achieve this, interface design should minimize the burden of functions that may experience reduced demands such as, working memory, visual functions and motor skills for older users. However, the games should be easy to learn but challenging. Participants did not encounter any restriction and all the cognitive skills examined increased. It is necessary to be patient and careful to ensure that seniors learn more easily and being more successful. At the same time, those with single hand paralysis or those who are not single-arm people can play mobile games with one hand, this can be promising for people with amputated.

In the direction of the above-mentioned developments, more mobile digital and serious games should be developed for the elderly population of approximately 1 billion. Despite this potential, the seniors are now disproportionately underrepresented as consumers of digital games, creating a significant market opportunity that is not being used. Towards the findings of (Aison et al., 2002) in digital games, the elderly people have negative perceptions of violence. The games that will play to seniors must be not violent and additionally the design should be made of fairly vivid colors that will not bother their eyes.

Mobile games that are developed considering the constraints of elderly people can be published with “this application is appropriate for the seniors” options on the Google Play Store and App Store. This way, the elderly will find the games that are suitable for them easier.

For future work, elderly people can be explored in another game platform or another game type because they are much easier to adapt to mobile devices. Issues that should be considered is to find or develop games that meet the needs, preferences and interests of the elderly. English is used as the primary language in most digital game. It will always be advantageous to add extra language options other than English.

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