

**A GAMIFICATION APPROACH
TO IMPROVE THE SOFTWARE DEVELOPMENT PROCESS
BY EXPLORING THE PERSONALITY TYPES
OF SOFTWARE PRACTITIONERS**

**A THESIS SUBMITTED TO
THE GRADUATE SCHOOL OF NATURAL AND APPLIED
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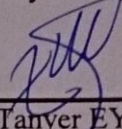
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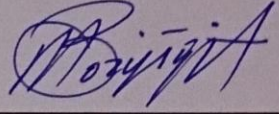
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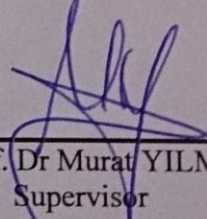
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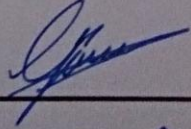
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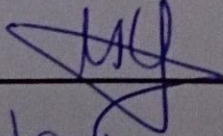
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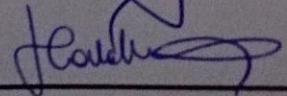
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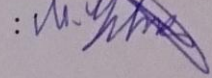


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Abstract

A GAMIFICATION APPROACH TO IMPROVE THE SOFTWARE DEVELOPMENT PROCESS BY EXPLORING THE PERSONALITY TYPES OF SOFTWARE PRACTITIONERS

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Although there are various kinds of processes designed to manage the complexities of software development, it is still a challenging endeavor. Recently, a significant number of researchers have started to investigate the social problems such as incompatibilities with respect to personality that is likely to be encountered in all stages of the software development process. However, there is no computer-based artifact to reveal the personality types of software practitioners. To bridge this gap, a virtual 3D assessment environment is developed with the ability to immerse individuals similar to a realistic model of the assessment. The interactive questionnaire is based on previous interactive personality assessment framework, which was particularly designed for software engineers. Based on the developed tool, a study is conducted on software practitioners. The data gathered via a survey study from software practitioners is analyzed to observe the difference between the results of paper-based and interactive tests. The analysis of research states that there is a significant difference between the results of participant's survey scores. Overall, these results indicate that proposed tool is relevant to help software professionals to improve the software development process when personality is in consideration.

Keywords: Software development, development process, gamification, video games, personality, MBTI

ÖZ

YAZILIM GELİŞTİRİCİLERİN KİŞİLİK TİPLERİNİ KEŞFEDEREK YAZILIM GELİŞTİRME SÜREÇLERİNİ OYUNLAŞTIRMA (GAMIFICATION) YAKLAŞIMI İLE İYİLEŞTİRİLMESİ

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Yazılım geliştirmek için çeşitli süreçler olsa da, yazılım geliştirmek hala zorlu ve gayret gerektiren bir alandır. Yakın geçmişte, kişiliğe bağlı uyumsuzluk gibi her yazılım geliştirme sürecinde ortaya çıkabilecek sosyal problemler üzerine inceleme yapmak için kayda değer sayıda araştırmalar başlamıştır. Ancak, yazılım geliştiricilerin kişiliklerini açığa çıkaracak bilgisayar tabanlı bir uygulama yaratılmamıştır. Bu boşluğu kapatmak için, gerçeğine uygun sanal, üç boyutlu (3B) uygulama ortamı geliştirilmiştir. Geliştirilen bu etkileşimli anket daha önce bilhassa yazılım mühendisleri için geliştirilen kişilik uygulama sistemine dayanmaktadır. Geliştirilen uygulamaya dayanarak, yazılım geliştiriciler üzerinde araştırma yapılmıştır. Yazılım geliştiricilerden anket araştırması yöntemi ile elde edilen veri, kâğıt tabanlı ve etkileşimli testlerin sonuçları arasındaki farkı gözlemlemek için analiz edilmiştir. Araştırma sonuçları katılımcılardan alınan veri ile yapılan anket araştırmasında gözle görünen farklılıklar olduğunu belirtmektedir. Genel olarak, kişilik dikkate alındığında, sonuçlar gösteriyor ki, önerilen araç yazılım uzmanlarına yazılım süreçlerini iyileştirme ile alakalı yardımcı olmuştur.

Anahtar Kelimeler: Yazılım Geliştirme, Yazılım Süreçleri, oyunlaştırma, video oyunları, kişilik, MBTI

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List of Abbreviations

MBTI	Myers-Briggs Type Indicator
SRS	Software Requirements Specification
SDD	Software Design Description
MUD	Multi-user Dungeon
MMO	Massive Multiplayer Online
RTS	Real-time Strategy
RPG	Role Playing Game
MMORPG	Massive Multiplayer Online Role Playing Game
NEO-PI-R	Revised Neo Personality Inventory
UX	User Experience
3D	Three Dimensional
2D	Two Dimensional
GIF	Graphics Interchange Format
FBX	Filmbox format
IBM	International Business Machines
SPSS	Statistical Package for Social Sciences
VR	Virtual Reality
UI	User Interface
PC	Personal Computer
MAC	Macintosh
XML	Extensible Markup Language
NASA	National Aeronautics and Space Administration
HALO	Highly Addictive sociAlly Optimized

Chapter 1

INTRODUCTION

Software development is an engineering discipline that encompasses a systematic design, production and maintenance of a software product. An improvement of such a product is visible in every part of lives. Development of new technologies such as hardware improvements and affordable technological devices made this field of business more valuable. As new technologies emerged, branches inside software development started to blossom e.g. web development, embedded system development, etc. Video game development is one of those braches that is developed as a sub field of software development, which requires a process for developing digital (video) games. Just like other software, digital (video) games also require scripted instructions. Moreover, other than the end-product and methodology, software and game development has no other differences. Through game development, video game industry has been created. Overall video game industry became noticeable because in year of 2013 consumers spend \$21.53 billion on game industry [33]. The popularity of game industry has pioneered to new approaches such as gamification. Gamification is a new field of research, which improves any business process by adding game elements in a non-game context [29, 85, 54]. Gamification relies on autonomy of an individual as well as the experience that is captured in video games. For this reason, through gamification it is possible to have people to participate in some certain activities e.g. taking a poll or quiz. In addition, gamification and video games have also leaded the way to identify personality type (theory of psychological identification of an individual's preferred to be) of an individual.

The term personality comes from Greek word persona, which is seen in Greek comedies and tragedies in about year 200 [13]. From its origin to today, personality is still in use. Today personality types mostly been used on job interviews, and employers [13]. The meaning of personality described as reference of different individuals responses for the different situations or events through psychological tendencies such as behaviors or traits [62].There are various ways to detect personality of an individual but for this study, Myers-Briggs personality type indicator (MBTI) is chosen. MBTI is a one of the common ways to reveal personality types of individuals. It is based on Jung's theories about personality types and it

summarizes them in 16 different types. However, none of these 16 types has a direct advantage over any other defined types [16]. Therefore, in this study the MBTI is going to be use to reveal personality type of software developer practitioners. Rather than using MBTI traditionally, it is going to be used in an interactive assessment environment because of disadvantages of a traditional personality assessment e.g. ambiguity, cost and reliability [74].

Thorough combination of MBTI, gamification and video games, this study aims to identify personality types of software practitioners by having them to play the interactive assessment built for this study. The personality types will be extracted by applying MBTI type indicator via the game-based approach to reveal the usability of the game application. After that, results will be reviewed to identify the personality types.

This thesis includes;

Chapter 2: Literature research and background information related to theme of the thesis. Definitions and detailed information of certain concepts such as software development, personality, video game and gamification that are related to thesis included in chapter 2.

Chapter 3: Methodology and process of data gathering stage of the thesis is explained in this chapter. It contains techniques and ways to conduct this research and mentions about the participants and the interactive personality assessment that created for this study.

Chapter 4: This chapter describes the tools and techniques that have been used throughout the process of interactive assessment development. In addition, it presents how the data is stored via interactive assessment.

Chapter 5: This chapter presents the results and analysis of the obtained data for the research. The tested results are documented via visual elements.

Chapter 6: Summary of findings and explanation of future work are given in chapter 6.

Chapter 2

Review of Literature

2.1. Introduction

This section of the study reflects the related work and background information that relevant to the theme of the thesis. Throughout, Chapter 2 software development, personality and personality indicator, games mostly video games and gamification is present. Chapter 2 starts with general definition of software development and tasks or processes that software developers require to go over. After that, definition of personality and MBTI personality revealing assessment is present. The MBTI section summarizes the MBTI and personality types that MBTI contains. Moreover, chapter 2 continuous with personality factor in software development by presenting the literature research. Then the video game related research is available. Game related research contains background information of video games, genre study in video games, definition of gamification and examples of usage and video game related personality study.

2.2 Approaches to Software Development

Software development has been around over 40 years [62]. Throughout of its existence, it has utilized by many fields of applications such as finance, military business and medical - domains. Software development became very significant part of twenty first century since; our civilization became more depended to software technology.

Over the years, software development has also evolved. Eventually, techniques and skills required over decades ago are no longer applicable. The result of this short noticed evolution created newly developed software process models. Software process is the set of activities to produce a software product. There a four common activities of software process [70,65,10, 68];

- 1) Software specification is a process of gathering customers and software engineers, to discuss and define about the software product to be created [70].
- 2) Software development is an activity where the actual software is designed and programmed [65].

- 3) Software validation is an activity to ensure that produced software meets the requirements of its customer [10].
- 4) Software evolution is an activity to modifying the software, to adopt for changing market and customer requirements [68].

Depending on business field, development process may differ. For example, military projects are different than commercial projects or web project so the approach to development is also different.

Software process model is defined as set of activities to apply software process [52]. The most common software process models are waterfall model, spiral model, rapid and agile development. These models use separate process phases;

- Planning
- Requirements Specification
- Prototyping
- Software Design
- Component Implementation
- Testing
- Delivery

By applying these process phases to process models a software product is created. In addition, for every different type of software process model, the phases above may also differ.

Waterfall model is one of the first published models, which contains requirement specification, software design, component implementation, and testing and maintenance processes [70, 68, 52]. Waterfall starts with requirements specification and end with maintenance process. In waterfall model, there is feedback mechanism to previous steps because of this before initializing next phase; current phase needs to be finished completely. The name waterfall comes from this notion as waterfalls never go back the direction where it comes from.

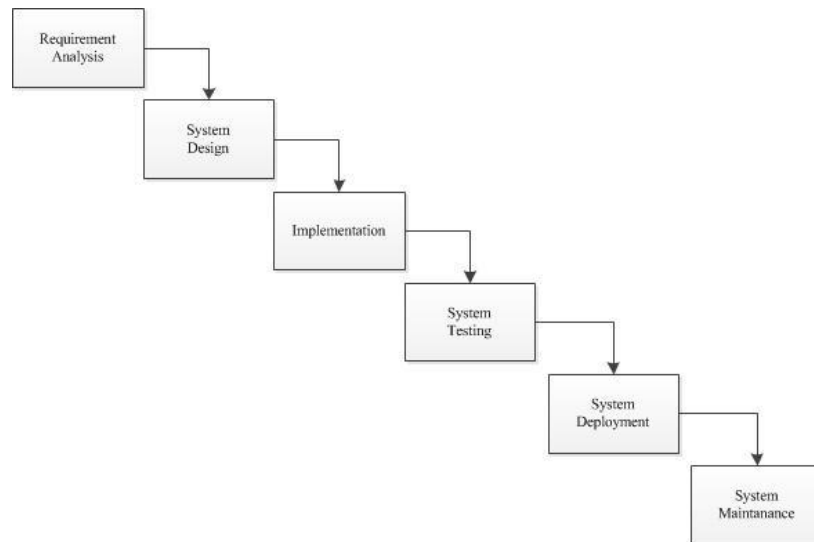


Figure 1 Waterfall Model adopted from [70]

Rapid Development exists, because of business around the globe started to operate rapidly changing environments. The goal is to produce a software product quickly. The approaches of rapid development are incremental development, agile methodology and extreme programming.

Incremental development is a way for providing working part of a system to its user's rather than the whole system and adding the rest of its functionality at a regular basis. This method allows periodically release software maintenance updates and services to users. Therefore, it's a popular software process model and used by a number of software firms and research centers e.g. IBM and NASA [65].

Back in 80s and early 90s, there was common belief that the best way to create software was applying phases of development process with careful planning and detailed documentation rigorously. This seems to be achievable by large businesses since they have enough people for every individual phase. However, when this belief urged to implement by middle or small scale businesses it created overhead that eradicated the whole development process. This inexpediency led to proposition of new methodology called agile methods. Agile methods intended to propose working software to its customer more quickly. This new method focuses on quick and time-boxed development rather than creating heavy documentation [70, 65, 68].

The best know and most broadly used agile methods, Extreme programming (XP) was proposed by Beck on 2000 [70, 65, 68, 52]. It brings iterative development and customer involvement together to create extreme level of project involvement. In extreme

programming, all requirements are defined as user stories. Programmers work as pairs and test these stories before start coding. In order for smooth transition, every code that integrated must successfully pass all existing tests [65, 68, 52].

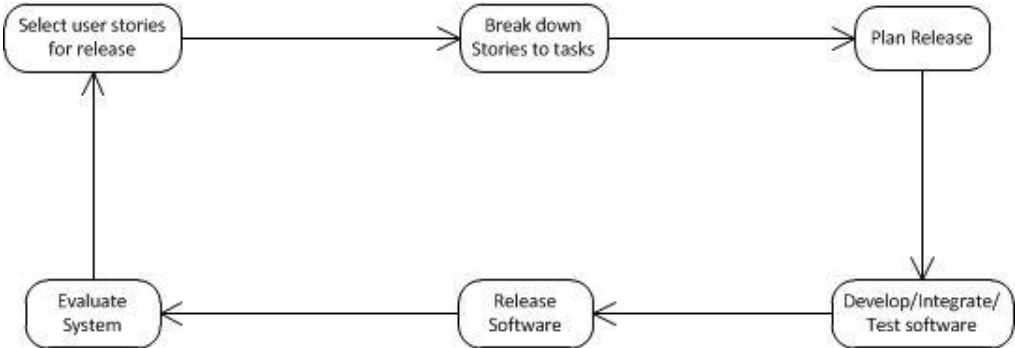


Figure 2 Extreme Programming cycle adopted from [70, 52]

One of the practices contained by extreme programming is pair programming [70]. In pair programming software developers literally sit together in front of same computer in order to develop a software product. The idea behind pair programming is that pairs are created dynamically so that every developer who participating in software development may work together while at programming stage of the development process [68]. The advantages of pair programming are shown in the table below.

Common ownership and responsibility	The team has collective responsibility for solving problems of clarity of software owners and coding [70,30]
Code inspection and review	Each line of code is checked by at least two people.[70,30,68]
Refactoring	Rewriting parts of code to improve or fix[70,30,52]

Table 1 Advantages of Pair Programming

As mentioned before, documentation phase resides in software development process. Although, there are many different ways of documenting the process of software development, the two commonly known documentations are SRS and SDD. SRS document is a kind of contract between client and provider. It informs the client about whole project. SDD on the other hand is a document that informs people who develops the project from scratch.

2.3 Definition of Personality

Before fully grasp the theory of personality, personality types need to be understood. From earliest times, a number of attempts were developed to create a system of typology to indicate among numerous functions and behavioral pattern have lead to born of personality types [66].

Types are a rating system that based upon observations on emotional and behavioral patterns as well as experiences and preferences of an individual [66]. Personality types have different opposite polar categories that classify a person [61], from this opposite polar categories, -an individual cannot be both consecutively - personality prediction seems possible as Buss indicates that personality types are unique defining characteristics of personality [15]. Therefore, personality refers to involvement of everything about an individual. The situation leads to various definitions of personality among the literature [35, 45, 60]. Funder states that personality is the combinations of psychological mechanism and a person's characteristic patterns of thought, behavior, and emotion [35]. In addition, Larsen and Buss describe personality as a set of psychological types and mechanism of a person that are organized by interactions of *intrapsychic*¹, physical and social environments [45]. Pervin et al. [60] refer personality as an individual's characteristics clarified by certain patters such as feeling, thinking, and behaving.

2.4 Briefly Myers-Briggs type indicator (MBTI)

Myers-Briggs type indicator is an extension of Carl Jung's theories over human personality that was published in 1921 [47]. Jung's theory of personalities consists of 8 personalities (two attitudes paired with four mental functions) [47]. Katherine Briggs and her daughter Isabel Myers have added a new dichotomous pair and published MBTI firstly in 1962 and it became widely used tool for indentifying an individual's personality type [62]. Along with Jung's theories, MBTI has four dichotomous pairs as follows,

- Extroversion vs. Introversion (E-I): In literature, the usage of these terms is defined by Jung himself. Extroversion means "outward" whereas Introversion means "inward". Jung's theory on personality type states that there are two worlds for a person's to focus his/her mind out world and in world [62]. Extrovert people are talkative, outgoing and initiators while Introverts are quiet and reserved
- Sensing vs. Intuition (S-N): MBTI defines Sensing as a reality driven and Intuition as abstract driven function. Sensing people like to live in real and actual whereas Intuitive people like to look towards future and possibilities [62].

¹ **Intrapsychic** is a psychological term referring to systematic thinking of the individual within mind or psyche.

- Thinking vs. Feeling (T-F): MBTI scale defines Thinking as a logical way of making decisions by using reasonable, logical and consistent given set of rules. Feeling on the other hand is defined as using emotions and "inside" feelings to come up with a decision [18].
- Judging vs. Perceiving (J-P): Judging and Perceiving is coined by Briggs-Myers. Judging is tendency of being extremely strict and disciplined whereas Perceiving is being flexible and spontaneous [18].

Combination of these 4 different dichotomous pairs creates 16 different types of personalities and each of 16 different types is demonstrated in table below.

ISTJ	ISFJ	ESTP	ESFP
ISTP	ISFP	ESTJ	ESFJ
INFJ	INTJ	ENFP	ENTP
INFP	INTP	ENFJ	ENTJ

Table 2 The 16 MBTI personality types [20]

ISTJ type individuals are quiet but serious, dependable and organized persons who are realistic and responsible and these people use their logic when decision-making and act towards without distraction [75].

ISFJ type individuals are quiet but friendly, loyal and responsible persons. They give utmost attention to specific things or feelings of people who are important to them and these people are committed to their obligations through consistency and accuracy [42].

INFJ type individuals are tending to look for sense and connection between concepts, links, etc. and these people want to figure out what derives other peoples. Hence, they are insightful to other people and to achieve their vision INFJ's are become organized and deceive beings [43].

INTJ type individuals are skeptical, critical and independent, they have high driven to implement their own ideas and if they committed, they can organize a job and become successful through determination [20].

ISTP type individuals are quiet observers, tolerant and flexible. When a problem occurs, ISTP type individuals act swiftly to overcome to problem by analyzing rigorously until to find the core of the problem. They want know how and why mechanics of things work [43].

ISFP type individuals are quiet but friendly, sensitive and kind who are dedicated to their values and loyal to individuals who are significant to them [66].

INFP type individuals are idealistic, friendly, flexible and curious and they are loyal to people important to them, they seek a life to compatible with their values [20].

INTP type individuals are quiet, flexible, and analytical and they like theoretical subjects and ideas more than involving in a social interaction [42].

ESTP type individuals are flexible and tolerant but they got bored when facing theoretical and conceptual explanations, they want to act immediately when a problem occurs and their motto is best way to learning is by doing [43].

ESFP type individuals are friendly, accepting and flexible. This type of people loves life and other people and they want make new things with other people and bring common sense, realistic approach and fun to work or group. Their motto is best way to learning is trying to do with other people [75].

ENFP type individuals are enthusiastic, flexible and imaginative and this type of individuals is quick to see the connections between events and come up with a solution to a problem, if interested this individuals can do almost everything they want [62].

ENTP type individuals are quick and ingenious and they are skillful problem solvers and good at reading other people but they get easily bored by routine tasks and they rarely do the same thing [18].

ESTJ type individuals are practical and realistic who likes to organize projects and people and these people take care of routine details but there are not interested in subject to useless to them. In addition, they want other individuals to follow their own standards [42].

ESFJ type individuals are talkative, popular and loyal, they want to work in a harmonious environment with other people in order to finish the work in time and they care what others needs and try to satisfy those needs [43].

ENFJ type individuals are responsive, responsible, sociable and popular, this type of person is resilient to criticism and praise and they feel highly aware of the feelings and needs of people around them [20].

ENTJ type individuals are honest and decisive leaders who are quick to differentiate what is not logical and inefficient because of this, they can immediately come up with organized solutions and they enjoy setting long term goals [42].

2.5 Personality Types and Software Practitioners

The literature review suggests that conducted research about personality of software engineers are focused on methods of educating software developer candidates or students, personality related job performance, forming a successful software development team, effects of personality on pair programming, and applying right person to software development roles by personality. Apart from MBTI, the usage of other methods e.g. Big-Five personality traits, Five Factor Model, NEO-FFI, and HEXACO observed in the researches. Although, MBTI is one of the common personality definition instrument it has some psychometric limitations. It measures about 30-35% of the personality [14]. MBTI puts a great emphasis on cognitive styles than the other personality instruments and provides simple description of Carl Jung's personality types [14]. In addition, personality traits that defined by MBTI does not exact projects of personality of an individual; it is rather a choice (preference) of individuals about personality [19]. Hence, MBTI identifies preferences for occupation but it does not make prediction about job success [19]. Hardiman suggests in his articles [39] that how well MBTI personality test predicts who will be a good software programmer. 60 people participated and the results of study show that though, the sample size is small, Hardiman derives a conclusion that the MBTI is a valid instrument of determining the personality types of software engineers as well as predicting who will be the good software engineer.

Capretz [16] investigates alternative ways for teaching students rather than using traditional methods. He claims that everyone has a different concept of understanding and it is possible to create new ways of teaching students that have various personality traits. He uses MBTI to identify personality of participated students and acts through them. The result of his study shows that personality involved teaching increases students learning performance. In addition, the findings are showing that for every type of personality there should be a corresponding way of teaching. In addition, Salleh et al. [64] are also work with software engineering students. In [64] they tend to improve pair programming's effectiveness on software engineering students and measure academic success of students by using personality on paired performance. They find out that 88% of the students were satisfied with paired programming approach and 87% of students' remarked that their level of confidence have risen when

working in pairs. Further, the results also shows that, regardless to personality tendencies, pair programming also brought enjoyment and enchased learning motivation of student's.

Software development is a process of applying series of laborious tasks to produce software as a product. Each task or phase in the development process corresponds to a different professional skill such as system design, analysis, programming, testing and maintenance. These tasks require adequate individuals to complete. Since the tasks are not the same, it is expected to individuals who are responsible for these tasks are not same also. Capretz [18] and Hardiman [39] claim that individuals need to be assigned to processes in software development according to their personality type.

Personality is one of the human factors that exist and it is one of the well known human factors affecting the development of software product presented in literature since it affects software quality productivity, and performance [73]. Study of personality started over 100 years [69] and for many years, researchers having a debate that whether human factors should be involved with software development or not [73]. Human factors are one of the risk that to be addressed within risk management since it effects the success of product. Omar et al. [57] approach this situation with their rough-set method to identify the relation between team personality and software product quality. The findings of Omar et al. [57], though the small sample size, indicates that success of software product depends on balance of personalities in software developer team. Moreover, it is also discovered that in order to form an effective team there needs to be feeling (F), thinking (T), and sensing(S) exists among team members. Hence, team member's personalities needs to complimentary with each other [57]. This research shows that among software developers there needs to be variation of personalities. However, this does not imply that any type of personality is more beneficial than other, it simply suggest that some personalities are more applicable for certain cases [62]. Similarly, in [17] Capretz focuses on relation between psychological types -created by Carl Jung- and software engineering. His survey, participated by 100 (professional software engineers) individuals suggests that software engineers are most likely to be STs or TJ or NTs. In addition, this shows that though there are other traits in software engineering, some specific traits are more likely seen in the field. Sach et al. achieved similar results in [62]. They applied MBTI to already published data ranging from 1985 to 2003 by various USA corporations. The presented results indicate that ISTJ, INTP, INTJ, and ESTJ are the types that mostly apparent. Furthermore, comparison of the result and USA population show that thinking has the highest score. Contrary to results of Omar et al. [57] feeling does not

appearing but the findings also showing that appearance level of thinkers are obvious. Additionally, Cunha et al. [26] verifies the relationship between, personality, and being an efficient code reviewer or debugger. As a personality detection instrument, they used MBTI on second year undergraduate students. The results indicate that among 64 students', individuals who were defined as NT types achieved highest scores. Therefore, this type of personality is good at debugging processes. The authors also suggesting that in order to define personality types as four letter words e.g. ISTJ, sample size required to be more than 64.

Acuna et al. [1] analyzed the connection between personalities, task characteristic, team processes, product quality, and job satisfaction among software development teams in [1]. They conducted a research on second year computing students and from those students data is gathered for analysis. Although, data for personality detections collected by Big-Five personality traits -which was the main approach-, Likert scale and NEO-FFI were also used in the process. Result of this study shows that, job satisfaction is related to high scores of agreeableness and contentiousness. However, the high level of satisfaction and devotion creates task conflicts between team members. In addition, there is a significant relation amongst extraversion personality factor and quality of software product. Hence, the study states that for a better software product quality in agile development methodology, extraversion is significantly related.

One of the duties of software project managers is to divide software developers into teams and assign individuals to development roles. Software development teams need to be formed so effectively that the whole development process does not fail. Project managers need to consider other parameters than skills and experiences when forming a team [73] since assigning right people to corresponding role is crucial for whole development process [2]. Managers or leaders generally assign people to development roles by experience, heuristic knowledge, subjective perception, instinct, preferences, technical knowledge, and job leveling [2]. They should optimize the assignment methods with factors above and personality [73]. Gilal et al. investigate the connection among types of personality and software team roles mainly team leader and programmer roles in [36]. The study uses rule-base approach based on rough-set approach with MBTI. The study shows that significant relation between personality types and development roles. Toward an effective team, extrovert types are required. In addition, for having an effective team leader, software development team needs to be heterogeneous (a team having various personality traits) as well as team leader needs to have diverse (I, N, T) personality. Furthermore, in order to having effective programming among

team, T (thinkers) programmers has to exist and the team must be consists of homogeneous (a team having same types of personalities) individuals. Omar et al. [58] demonstrate similar results in their study. They are offering a way to analyze the types of personality and diversity in team to determine the performance of software engineer's team. Eighty (80) third year undergraduate participants were involved in the research. MBTI was also in use. The analysis of the study resulted that, forming a heterogeneous team has a great effect on quality of software and combination of team personality. Heterogeneous teams proved that in case of high quality product demand that requires innovative ideas, they were more creative. However, the situation also creates a drawback, when developing for less demanding project, heterogeneous were less effective because their abilities were not tested to display their full potential for solving problems. Contrarily, a team formed by homogeneous personality types was more comfortable with less demanding requests. Hence, homogeneous team was hindered to develop a quality product since the team members have almost the same perception. This raises awareness, when assigning a team into a project which team is going to be chosen for that particular project [58]. Software engineering can benefit from having diversity among team, in order to overcome obstacles, since different individuals have different perspectives [19]. However, assigning adequate person into software development roles is not an easy task to deal with, due to many factors e.g. human factors, skills...etc to consider. Stylianou et al. [73] propose a multi-objective generic algorithm for team stuffing among software developers. The algorithm optimizes the required technical skills, knowledge, and abilities for development role and personality traits in order allow project managers to form a team and assign the right team into right project. The result of the experiment indicates that the proposed algorithm is capable of composing sufficient solution when balancing human factors and technical aspects. Similar to study in [73], Sodiya et al. [69] also researched software team stuffing methods. They developed an assessment method to assign software developers into adequate development roles by using personality traits. Rather than creating a generic algorithm, Sodiya et al. [69] created an online questionnaire and handed 112 team leaders. These team leaders collected personality and performance information from 489 software practitioners based on Big-Five personality traits. The collected results were then analyzed for each role in software development process. After that, 58 senior students were tested to define the corresponding development roles via their personality. The proposed work resulted as a successful tool for assigning software engineers into development roles. Finally, Dick et al. [30] aimed to determine the required personality traits for paired programming to achieve success. In order to do that, they paired 2 senior and 4 junior software programmers for a real

software development project and observed the pair performance throughout the project to determine the necessary personality traits for pair programming. The results indicates that for an adequate pairing in pair programming participants ought to have; effective communication, confidence in to own abilities, comfortableness working with others, and ability to compromise.

2.6. Video Game Influence on Human Behavior

This section of paper contains the game related research of the thesis. The section starts with the definition of general definition of game in literature. It continues with history of video games and video game genres. After that, this section presents literature research about possibility of personality detection via video games. Lastly, gamification and example usage of gamification is exists in this section.

2.6.1 Definition of Game

Games are essential part of human existence as well as ancient as human history [23]. Yet the controversies occur when one tries to seek the definition of games [21, 24, 11, 9, 63].

Clark defines games as an activity that having two or more participants to achieve certain goal using decision making [21]. He then goes deep and adding games are activities within certain rules that adversaries trying to win or achieve the goal [21]. However, his definition is partially false because not all games have adversaries, rather cooperation. Costikyan [24] indicates that game is form of art that participants called player pursuits the goal by in-game resource management (game tokens) as well as decision-making. Suits [11] defines games as a voluntary effort to get through unnecessary/artificial obstacles. Similarly, Avedon et al. [9] also define games as a voluntary effort, they go further and adding games are embodiment of player conflict, which consists of rules to produce *a disequibral outcome*². At this point, it is clear that games in common have voluntariness, rules/goals and artificial conflict. Salen et al. [63] define games as system that having participants as players to engaging an artificial conflict to achieve a quantifiable outcome within given set of rules. Quantifiable outcome in this context means that when the game is over player wins or loses or gets numerical representation of his/her effort such as score or rating.

² In this context, *disequibral outcome* means when game reaches its end state, the game likely has a winner and a loser

Games have many forms. Digital games are the one of the form among games. The definition of digital games is the same as the game itself. One different is that in digital games computer acts as an opponent, ally and referee [23].

2.6.2. Video Game History

The history of games and gaming is as ancient as history of mankind. Back then, the purpose of games was survival or winning a war in real life. For instance, a game like chess was different in old days. It was played by generals of vastly armies in order to surpass the opponent by designing a winning strategy. The invention of video games allow us to simulate the same purpose of games for achieving different outcomes since everything is different from back then. The history of video games has begun with a device entitled as "cathode ray tube amusement device" which was created by Thomas T. Goldsmith Jr and Estle Ray Mann on February 25, 1947 [40]. This device were working like a flight simulator, by using the knobs and buttons on this device a user could control cathode ray tube beam to shoot down the targets on the screen. This device has started the era of video games. After that in 1950, a game called "Bouncing Ball" has created by Charley Adama but this game was not interactive as a game should be [23].

In 1958, by using oscilloscope and analog computer, William Higinbotham created a game called "Tennis for Two" [44]. This was maybe the first game that has individual controllers and multiplayer feature. After this game, its successor Pong has released. Apart from Tennis for Two, there was no tennis court in this game; there were only two blocks and a ball hitting these blocks. Figure 3 and Figure 4 shows respectively the game entitled "Tennis for Two" and "PONG".

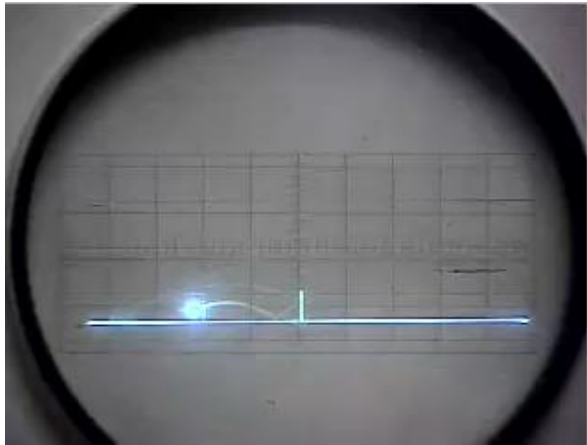


Figure 3 Screenshot of Tennis for Two

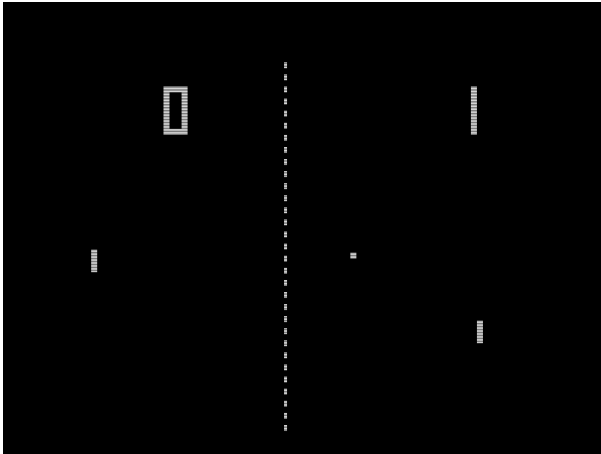


Figure 4 Screenshot of PONG

Between 1959 and 1961 a new set of interactive programs were created by MIT [40];

- Mouse in the Maze: allowed player to form their own maze then watching a mouse in maze to trying to find a cheese.
- HAX: allowed users to create interactive graphics by playing with the two switches on the console.
- Tic-Tac-Toe: made possible to play traditional tic-tac-toe game versus computer by using the light pen (a kind of pen used for controlling a computer).

Eventually many games have been released after the games above. However, not all of them have become the most anticipated games in the game history and the ones that took its place in game history never be forgotten. Games such as Pong, Frogger, Spacewar, and Space Invaders are still popular among core game communities.

2.6.3. History of Multiplayer Games

The history of multiplayer games started with the development of certain games like PONG and Tennis for Two. These two significant games have created a phenomenon in gaming industry. In fact, two were almost the first games that require fully user interaction, which also supported multiplayer gaming. As a reference to today's multiplayer games, these two games were like having two controllers to control the sticks on the screen. The screen was not split into two since there was nothing besides to split. The other games that released later and support multiplayer features were the same. However, in 1979 Roy Trubshar and Richard Bartle has developed new genre of multiplayer games described as multiuser dungeons or MUD [27]. MUD's are text based games with no graphical interface and in order to proceed through the game, an individual must write some meaningful commands. This text based games and its variations, have thousands of people to gather on a server and allowed exploring the dungeons with together [44]. Figure 5 below shows that a screenshot from a multiuser dungeon in which player of the game tries to process throughout of the game by typing commands.

```

*~
Path.
You are standing on a path which leads off a road to the north, to a cottage
south of you. To the west and east are separate gardens.
*~
Flower garden.
You are in a well-kept garden. There is an unexpectedly sweet smell here and
you notice lots of flowers. To the east across a path there is more garden.
*~
Cliff.
You are standing on the edge of a cliff surrounded by forest to the north and
a river to the south. A chill wind blows up the unclimbable and unscaled
heights. At the base of the cliff you can just make out the shapes of jagged
rocks.
*~
As you approach the edge of the cliff the rock starts to crumble. Hurriedly
you retreat as you feel the ground begin to give way under your feet!
*~
You are splattered over a very large area, or at least most of you
is. The rest of your remains are, even now, being eaten by the seagulls
(especially your eyes). If you'd have looked properly before you leaped you
might have decided not to jump!
Persona updated.
Would you like to play again?

```

Figure 5 A screenshot from a Multiuser Dungeon (MDU) [86]

By the time of 1980s developing computer and graphic technologies, has offered graphical interface to multiplayer games. A game called Habitat created by Randy Farmer and Chip Morningstar in 1985 allows Commodore-64 users to access the virtual world by online service called Quantum Link [44]. It was a two dimensional (2D) game that included humanoid avatars (characters). Later on similar games like Rabbitjack's Casino, Yserbius and Air Warrior have released and all of these games were supported hundreds of players simultaneously while at that era, up to 16 players were supported by an average multiplayer game [80].

On 1990s since the technology developed further, the scale of multiplayer games have become larger. In 1996, the first internet based online-game and the first massive multiplayer game that used as marketing purposes, was 3DO's Meridian 59 was released [27]. Meridian 59 was the first MUD with graphical interface and it has created trends that continue in MMO (massive multiplayer online) gaming today such as chat system and character customization system [27].

In 1997, massive multiplayer online games became a new fashion movement around the world. On same year, highly anticipated massive multiplayer online game called Ultima Online released by the company called Origins Systems. At that time, its user population has exceeded two hundred thousand customers and become the first online game that demonstrates the true potential of MMO game industry [44].

Since the potential of MMO industry is highly profitable after year of 1997 many games that released at that time have supported online features and eventually more MMO games were released. A few MMO games significantly affected the world MMO games by contributing

new features to games. These games were; Everquest by Sony Online Entertainment, Asheron's Call by Microsoft/Turbine, Dark Age of Camelot by Mythic Entertainment, Star Wars Galaxies by Sony/Lucas Art and as a last World of Warcraft by Blizzard. Each one of these games except World of Warcraft has reach almost 1 million subscribers worldwide. World of Warcraft has reach 12 million subscribers worldwide and became the most anticipated MMO game in MMO history and made the MMO game industry even more popular.

2.6.4. Video Game Genres

The purpose of this section is, to make humble clarification on misunderstanding or misconceptions of video game genres [22, 46, 7]. In addition, since there is a development of game as a part of the study, it is opted to present this genre study.

Genre in video games, like all other media e.g. movie, and literature is for categorizing and organizing video games for easing the access to the media [22, 46]. Unlike other media, genre in video game field does not defined by rules, goals, outcomes, theme or story rather by perspective, overall game play or type of action, objective, etc... [22]. Despite of these, commonly presented category of genre exists such as action, adventure, simulation, strategy, platform, fighting, survival, role playing, rhythm, and serious games [22, 7].

Action game is a type of game that presents fast-paced events that requires quick reflexes and careful timing to overcome obstacles that game provides while without losing. It consists of two main categories: first person and third person games [7]. First person games are played as if the whole screen is the players own eyes where as third person games have an avatar (digital representation of player) that player controls [7].

Adventure games require players to solve puzzles inside game in order to progress. In order to solve puzzles players required to do activities such as pattern matching, reasoning and memorizing, exploring and collecting items. Depending on the game player has third person or first person camera angle [38].

In a **strategy game**, players are given a series of task or duties in which they make decisions that effects game play. Waging war, resource allocation, unit summoning and base construction are common goal that exist in this type of games. Strategy game has two sub-categories: real time strategy (RTS) and turn-based strategy. These two sub-categories share

same common goals of strategy game but in turn-based strategy games, players take turn to achieve goals [38].

Fighting games have at least two opponents to fight with each other to progress through game. Players are give avatars to fight in these kinds of games.

In **survival games**, the objective is to survive through various obstacles that game enacts. Popular sub-category of this genre is Survival Horror where player has to survive through traditional elements of horror fiction [38].

Role playing games (RPG) focuses of improvement of player's avatar, items, skills, etc..., in order to overcome obstacles and progress. The most popular version of this genre is massive multiplayer online role playing game (MMORPG) where it is the online version of classical RPGs [7].

Rhythm games require players to partake some certain actions that prompted on screen by game e.g. pressing exact buttons on screen in correct sequence or rhythm. Generally, music is stimuli factor for this genre [38].

Serious games are one of the game genres that focus on improving some specific aspects of knowledge sharing, education and learning other than entertainment [28]. More elaborate definition of serious games from Woude;

"A serious game is an activity in which one or more people attempt to reach or approach a goal while abiding to predefined rules which restricts their behavior while playing, the game is concerned with important rather than trivial matters, and is designed to be profitable" [77 ,pp. 2]

Since its purpose is to educating and raising awareness, serious games are used in certain fields of business e.g. emergency service training, military training, corporate education and health care [28].

Simulation games are considered as serious games because they reflect the real life more realistic way than the other games. Car, flight, sports games are popular ones for this genre since they simulate real physical activities. As genre choice for this research, simulation game genre is considered to more suitable for the game that is developed specifically for this study.

2.6.5. Games and Personalities

Advancement of (video) game industry provided possible ways to detect personality via observing game behaviors of individuals since there are various statistics and information about the player that are embedded inside a game. Tekofsky et al. [74] proposed a new way of personality assessment by using video games. The goal of this study is to find a correlation between spatial behavior³(game style) and personality. The data gathered from 13376 individual shows that spatial behavior offers complimentary correlation to personality. In addition, Miller et al. [50] conducted similar research to reveal personality via video gaming. They used one of the popular MMORPG title World of Warcraft to collect data since the game is very popular and game world is populated by vast numbers of players. They observed in game behavior of players in certain area called Arathi Basin, which is a player versus player (pvp) map. Even though, they did not conduct a personality research; their findings show that it is possible to get related data from a video game to conduct a research. Similarly, Drachen et al. [31] conducted a research on spatial behavior. The focus of this research was gathering telemetry data by using various clustering algorithms to create in-game behavior profiling. Their study shows that the provided methods/algorithms for analysis of clustered player behavior are successful. In addition, through player behavior profiling and the proposed methods can be used for large scale analysis such as personality detection. Yaakub et al. [83] approached personality detection by using a game-based theory. They created 4 different types of game to detect personality. 50 engineering students participate to test the precision of the approach and the results indicate that the precision of this new approach achieved 77.5%. Moreover, van Lankveld et al. [78] investigate whether relationship between personality and video game behavior exists. In addition, their study tends to find out that it is possible to detect personality by observing game (spatial) behavior of individuals. NEO-PI-R personality questioner test and a video game titled Neverwinter Nights used to reveal and compare video game behavior to personality. The result of the study indicates that personality and game behavior is related and based on the game behavior, van Lankveld et al. [78] able to produce accurate estimation of participant's personality. Similarly, Wohn et al. [79] claim that by observing spatial behavior, it is possible to depict an individual's personality. They were using Facebook game titled Cityville for this process. However, their findings shows that when compared real personality to the depicted personality from game behavior, there is a

³ Spatial behavior in this context means that interaction of an individual or groups of individuals with surrounding environment -including animate or inanimate objects- provided by 2D or 3D computerized areas.

distinction between who they think they are and who they want to be. In contrast to Wohn, Worth et al. [81] demonstrated distinct results. The purpose of study of Worht et al. [81] is to examine the connections of personality traits and behavior in video games. They result of this study shows that there are some clues indicating the connection between personality and video game behavior. In addition, the study suggests that, there is no distinction between behavior in video games and real-world behavior (personality).

2.6.6. Gamification Definition

Gamification is a newly introduced area of research that combines certain elements of games to create an expression between rewards and games. It is firstly introduces at 2008. However, it has become notable in 2010 [29]. Although, gamification is introduced recently in many businesses domains, have been using gamification for a long time e.g. employee of the month, flight mils. Gamification has various types of definitions and the variety of definitions creates confusions between similar but different concepts like serious games [85]. The variety of definitions is also causing incompetent design and implementation of gamification [85]. The purpose of gamification is to engage and motive the people by combining intrinsic behavior with extrinsic reward such as points, badges, and leaderboards [41]. Intrinsic behavior is the drive for to do something without an external reason [54] and extrinsic reward is tangible reward that visible to everybody. For instance, loyalty rewards that airlines and hotels providing to customers [54]. In order to serve its purpose gamification uses main features of video game elements - player, environment, rule, challenge, goal, interaction, emotional experience, outcome and consequences- into context defined as non-game [85]. Thus, this indicates that game which has all of the game elements, cannot be involved to be gamification process [85]. Therefore, gamification is defined as a process of integrating game elements (badges, scores...) into non-game context in order to create motivation and engagement [29, 85]. Table 4 demonstrates some common game elements that being used within gamification. Game mechanics refers to rules, techniques and methods whereas dynamics refers to mechanics that depending on player's interaction and components refers to responses that game provides to player according to player's actions.

Game Elements		
Game Mechanics	Game Dynamics	Game Components
Challenges	Exploration	Badges
Feedback	Progress	Levels
Cooperation	Collection	Achievements
Time	Status	Points
Turns	Relationships	Quests
Scores		Groups
Ranks		Content
Rewards		Leaderboards
Resource		Virtual goods
Tasks		
Avatars		
Stats		
Transactions		
Win States		
Competition		

Table 3 Common Game Elements in Games

2.6.7. Gamification in Practice

Popularity of gamification leads to creation of new field of research that various articles about gamification in action exist in literature. In this section, usage of gamification in software development environment and other approaches that gamification involved in will be presented. Table 5 below demonstrates the various occurrences of gamification in business.

The reviewed literature about involvement of gamification in software engineering mostly covers educational purposes. For instance, Xie et al. [82] approach software engineering education by presenting Pex4Fun tool. They describe Pex4Fun as a web-site that consists of coding duel as its core. They using one of the game mechanics called "competition" to tend to improve;

- Programming
- Understanding the program
- Reasoning
- Debugging
- Problem solving

- Testing
- Writing software specifications skills of software engineers [82].

Similarly, Sheth et al. [67] propose a new method to teach software engineering. The purpose of their study is to improve software engineering students' engagement and ultimately teaching the basics of software testing by implementing HALO (Highly Addictive sociAlly Optimized) platform to certain lectures. Unlike Xie et al. [82], they are only focused on enhancing testing skills of software engineer students because of the reluctant approach of students to test the written code [67]. They conduct this study on two undergraduate computer science course and the result of the study shows that students who used HALO showed significant performance improvement ($p < .04$). Dubois et al. [32] proposes a method by applying gamification to software development cycle in order to improve software quality. Competition and challenge are the core components that lie inside of their approached method. Their study suggested that the proposed method had impact on improving software quality compared to methods that does not use gamification. In addition, Akpolat et al. [5] propose a new way of teaching software engineering students in order to effective participation and learning. With 50 volunteered participants, they conduct the research. Development task were given to students that contains various game elements such as weekly challenges and rewards. The study shows that about 80% of participants that answered online questionnaire about the course were positive regarding fusion of gamification and education. Similar to [5], Uskov et al. conducted a researched that again mixing gamification and education [76]. Moreover, the results that they received show that in some cases 100% of students were positive of having new type of learning method with gamification inside curriculum.

Gamification	Definition/Purpose	Game Elements	Rewards
Zamzee[41]	Zamzee is device that tracks physical activities of children ranging from age 9 to 15. Its purpose is to fight with obesity	Badges, Levels, Challenges, Achievements, Goals, In-System Currency, Avatar...	Virtual goods as well as real world items e.g. game consoles, toys and intangible rewards
Nike+[55]	Nike+ or NikeFuel is a wearable device that measure physical activities of the owners. The device connects to owners Nike+ account to store overall activity.	Badges, Feedbacks, Challenges, and Stats, Avatar, Achievements...	Intangible e.g. burned calories
Stackoverflow[71]	Stackoverflow is a website for coding professionals or coding enthusiast to ask/answer code related questions.	Badges, Levels, Challenges, Feedback, Stats, Avatar...	Intangible rewards e.g. satisfaction of getting an answer
FourSquare [34]	Foursquare is a search and discovery service that allow users to provide information about the places they being. Users can also make recommendations about places they have being.	Avatar, Badges, Progress Bar, Challenges, Stats, Achievements...	Intangible rewards e.g. joy of making a discovery. Tangible rewards e.g. free food
Speed Camera Lottery[12]	In 2011, Sweden hosted speed camera lottery for emphasizing road safety with Volkswagen. Participation of lottery was automatically done when drivers abide speed limit.	Feedback	Tangible reward, money from speeding fines
Carwings [56]	It is a smartphone app for the owners of Nissan Leaf electric car. The app lets users to check charging status of battery and get reminders or recommendations about ecological way of driving	Badges, Rankings, Stats, Feedback, Competition	Tangible rewards

Table 4 Various occurrences of Gamification

2.7 Summary

To sum up, the software development process consists of various activities and tasks. Each of these development tasks requires a suitable individual to deal with both in terms of technical and social skills. Personality is social construct, which contains some useful information for assigning adequate person to a corresponding development role. To reveal an individual's personality MBTI can be used. In addition, with spatial behavior tracking and MBTI it is possible to detect personality via using video games.

Chapter 3

Methodology

3.1 Introduction

Chapter 3 explains the proposed methodology and the data collections process. This section starts with brief information about the qualitative and quantitative research and continues with details about the procedure to be followed when gathering data, measurements in research, features of the both traditional personality and proposed interactive assessment tests.

3.2 Qualitative and Quantitative Research

Qualitative research is one of the well-known ways to conduct a scientific research. Scientific research consists of answer seeking through questioning; answering the question(s) with usage of systematic procedures for collecting evidence. Not surprisingly perhaps, the qualitative research has possessed such characteristics [48]. In addition, qualitative research means to collect data from experiences, behaviors, emotions or feelings of individuals rather than statistical information [72]. Qualitative researchers tend to understand the interpretations or interrelations between any gathered data in given certain time and context [49]. The data obtained for qualitative research consists of interviews and observations as well as documents, films or video types [72]. Therefore, qualitative research is good at gathering information about opinions, values and behaviors of individuals [48].

Quantitative research is another method for conduct a scientific research. Contrary to qualitative research, quantitative research requires data to be obtained as numerical form in order to make interpretation and analyses of data within rules of mathematically defined methods [6]. Therefore, it is essential for quantitative research that the obtained data needs to be numerical to explain or interpret for certain phenomenon. In order to conduct the research related to this study descriptive study type and survey sub type has chosen and because of these quantitative research and related analysis and techniques were followed.

3.3 Measures

Descriptive statistics, game play scale and Keirsey temperament sorter, were used to conduct this study. In descriptive part of measurements gender, age, education level were asked to fill in and this part of measurements is solely for demonstrating demographics of participants and it has no effect to analysis of findings. Game play scale is a 5-point likert scale consists of 12 questions such as "I like the graphics in the game" adopted from [59] and modified for both assessments to be able to rate the both of them (see Appendix B). The modified version of this scale contains questions such as "Aesthetically, the assessment was satisfactory". In addition, the answers to these 12 questions have five choices ranging from "*strongly disagree*" to "*strongly agree*". Based on the MBTI scale, Keirsey temperament sorter is a self-report psychometric instrument that can be used to reveal personality types of individuals. The assessment consists of 70 questions, which also reveals participants dominant temperament⁴. The purpose of using Keirsey temperament sorter is to reveal the participants personality by calculating answers they give, the questions on this temperament never been issued to participants (see Appendix C). Keirsey temperament sorter classifies individuals into four temperaments; idealist, guardian, artisan, rational. The individuals revealed as idealist are the combination of NF (intuition-feeling) pairs. Similarly, guardian is SJ (sensing-judging), artisan is SP (sensing-perceiving) and rational is NT (intuition-thinking) pairs [43].

3.4 Personality Revealing Questions

To reveal the personality type of software development personnel, a computerized personality assessment environment was developed. Similar to Keirsey temperament sorter it contains 70 questions. The personality related questions that were used in this interactive assessment was obtained from previous research [84], which aims to utilize a content specific (paper-based) personality revealing approach especially for software practitioners.

3.5 Procedure

For this study, a computerized personality assessment environment is created to observe, the more positive experience of the users of interactive assessment provided than paper-based assessment. In order to test this, the study utilized from user experience evaluation techniques.

⁴ Temperament means that the combination of actions, mental or physical tendencies and traits of an individual.

Basically, user experience study refers to a set of methods to measure the experience when a person interacts with a system, product or service in specific condition [8]. This set of methods contains ways such as interviewing, eye tracking and surveying, etc. In this context, survey study has chosen for this research and Game-play scale [59] adopted and modified for both interactive and paper-based assessments. The modified scale was issued to participants after each participant done with both of the assessments in order to make comparison to determine the differences between results of questionnaires for each participant via analytical tools.

- 1) The procedure of data collection begins with the distribution of paper version of personality revealing questions and participants were asked to fill the paper version of personality revealing questions at first.
- 2) After they filled the paper version of personality questions, they were given a questionnaire that adopted and altered version of [59] to rate the experience they have while filling the paper version of the assessment. While participants dealing with the questionnaire the researcher calculated the personality of participants and revealed to the participants afterwards. This part of the procedure took average 30 minutes. Whenever participants were done answering with personality questions and survey questions, the next part of the procedure started.
- 3) In second part of the study, participants were introduced with a computerized personality assessment environment that designed and developed solely for this study. PC version of the environment is used for this research. Participants played the interactive assessment and answered the questions in the interactive environment about 45 minutes. Personality of participants was revealed after all of the questions in the computerized personality assessment environment answered and participants were informed about characteristics and specification of their personality via the computerized assessment environment. Participants were asked to choose the same answers as they did with paper-based assessment to see accuracy of the game. Therefore, paper-based version of questions that participants were filled before the interactive assessment, handed over. The way of calculating the personality of participants is the same as the way inside Keirseley temperament sorter but instead using pen and paper this time script inside the computerized assessment handles it.
- 4) Once the play session is over participants were guided to fill the same questionnaire as in part one that contains adopted and modified version of game-play scale. The steps

of the procedure are repeated for each of the participants. Figure 6 show the steps and processes of the procedure

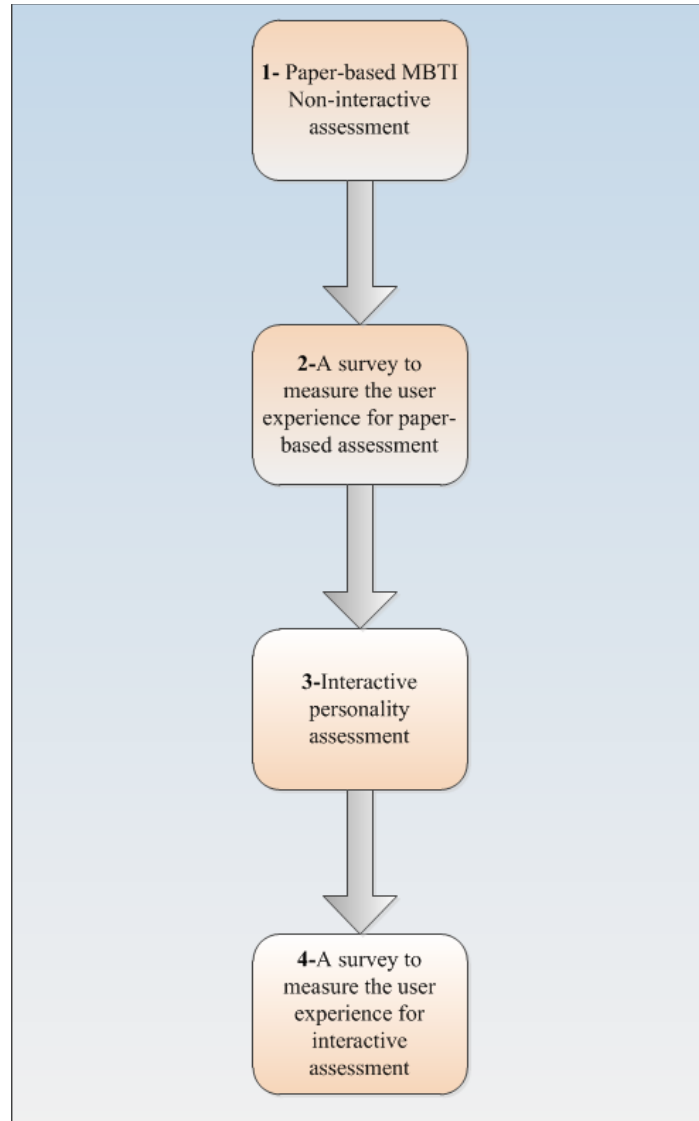


Figure 6 The Flow of Procedure

3.6 Interactive Assessment

The interactive assessment environment has two scenes Office and Game Over scene. Whole game takes places in office scene where the player is tasked to have an interview for software developer position. When the game starts player is given an objective indicating that he/she needs to speak the lady in reception for further instructions (see Figure 7).



Figure 7 Screenshot of the interactive assessment that depicts the Beginning of the Game

In conversation, the lady is telling the player that the interview will start whenever the player reaches the designated location, which in this case "meeting room". When the player goes to the designated location, kind of disclaimer window that contains written information about the situation becomes visible. The interview starts after the player reads the information on the screen and agrees with it (see Figure 8).

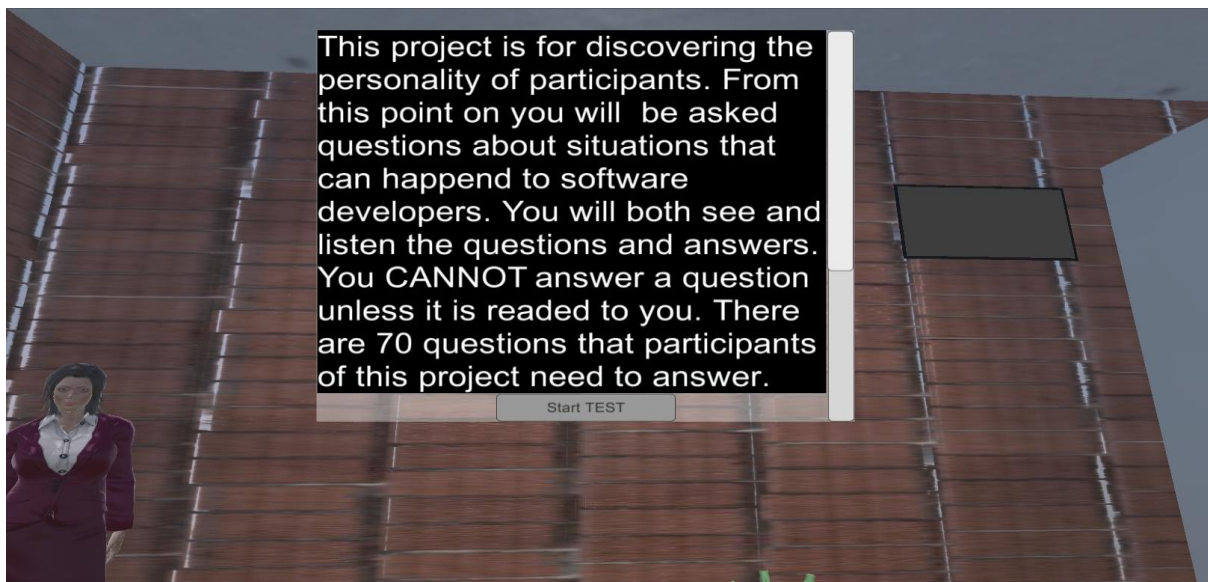


Figure 8 Screenshot from interactive assessment that show a part of the In Game Disclaimer

During the interview, players can only look around by mouse and mouse-click the answers of the prompted questions, they cannot move from the position they standing. As soon as the interview starts, the first question and its voice recording become noticeable. Players cannot answer the questions until the voice record of the corresponding questions stops and the

interview process goes through like this for all 70 questions (see Figure 9). When the all of the questions are answered by players, the game skips to the next scene - Game Over scene- to examine his/her personality (see Figure 15).

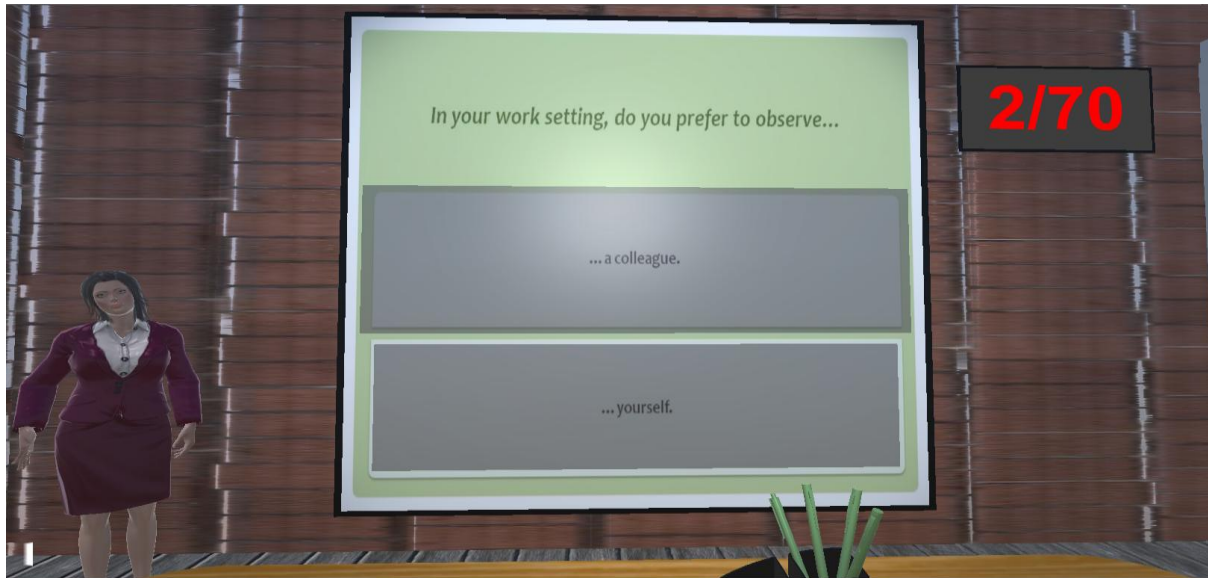


Figure 9 Screenshot from interactive assessment showing virtual Interview Process

3.7 Traditional Way of MBTI

In order to reveal personality by using MBTI certain set of actions needs to be accomplished. The series of actions starts with making decision between online sessions or face-to-face sessions for participating in personality test. MBTI test requires certified practitioners to conduct face-to-face sessions. Therefore, people who want to take the test are required to visit the certified places with certified practitioner. In these kinds of places individuals, take the pen and paper test and after they are finish, they receive appointment day/hour to get consultation about their personality. Alternatively, MBTI can be done online. Individuals take the test online and after they finish they receive call from one of the practitioner to get feedback about their personality preferences in an hour-long phone interview. Both online and paper-based test consists of more than 70 questions and require a certain amount of fee to take the test and receive feedback [75].

3.8 Features of the Interactive Assessment

The review of literature shows that software development became important part of everyday technology. Video games are the result of software development and it is hard to deny that they too became important business field. By using video game elements, it is possible to create a testbed to conduct a rigorous research. To reveal the personality types of software personnel, a computerized personality assessment environment is proposed. Actually, this is a digital version of paper based test that can be found in [84]. The digital version the personality test provides various benefits. The computerized personality assessment environment can be upgraded or patched to meet new requirements that can arise in the future. The assessment environment is a 3D (three dimensional) environment so anything related to 2D/3D can be used to in the environment e.g. animations, GIFs, videos, voice recordings, physics, etc. to simulate to real world or to create an alternative imaginary world. Moreover, environments can be changed or added to reflect current situation. Likewise, the questions in the computerized personality assessment environment can be changed or added to create a set of variety among questions. In addition, the way of asking/answering questions can be altered. Advancements in technology allow people to share information through internet. The computerized personality assessment environment can be distributed from the Internet to reach many people. Therefore, people can play the assessment environment whenever, wherever they want. In addition, the computerized environment can be downloaded to smartphones to reach out even more individuals. It is possible to save the in-game progress if time is a constraint and load it some other time to finish it. Finally, it is possible to get instant feedback to examine the performance or receive information about an individual's personality.

3.9 Participants

The research took place in METU Technopolis from 16.12.2015 to 21.12.2015. Participants of this study were the software practitioners who work different companies that reside in METU Technopolis area. There were 21 participants, 16 male (76.2%) and 5 female (23.6%) of this research. In these 21 participants, 5 (23.8%) of them were fall in "18-25" age category, 13 (61.9%) of them were in "26-30", 1 (4.8%) of them was in "31-35" and 2 (9.5%) of them were in "older than 40" (>40). In addition, among these 21 participants, 1 (4.8%) of them was high school graduate, 16 (76.2%) of them were university or college graduate and 4 (19.0%) of them were having master's degree.

Chapter 4

Design and Implementation

4.1 Introduction

In this section tools and techniques that utilize for the development of the interactive assessment environment is explained. Respectively, Blender3D, Mixamo, Adobe Premier Pro and Unity3D are the tool that this chapter contains. These tools are used because of previous experiences of the researchers' with the tools. In detail, Blender3D is free and the researcher of this study has undeniable experience with Blender3D's modelling techniques. Although, Mixamo have never been used before by the researcher, it provides fairly detailed characters for 3D environments with its fast character creation tools. Similarly, Adobe Premier Pro is present because of the prior knowledge of the researcher. Lastly, previous knowledge of researcher and popularity of Unity3D in game development lead to the usage of the tool in the research.

4.2 Interactive Personality Assessment Tools

The interactive assessment environment is a combination of various techniques and programs. Respectively, Blender, Mixamo Fuse, Adobe Premier Pro and Unity3D are used to design and develop the game.

Blender is a powerful yet open source 3D modeling, sculpting, animation, rigging, texture baking, rendering, painting, simulation, motion tracking and compositing tool [51]. Even though, Blender provides rich 3D development pipe-line, only the modeling part of the tool is utilized for this research. For modeling an office environment basic 3D objects cube and plane were used along with basic modeling techniques such as move, scale, rotate and extrude. Therefore, basic or base of the office environment is created inside Blender and exported as a .fbx file extension for Unity3D to further usage (see Figure 10).

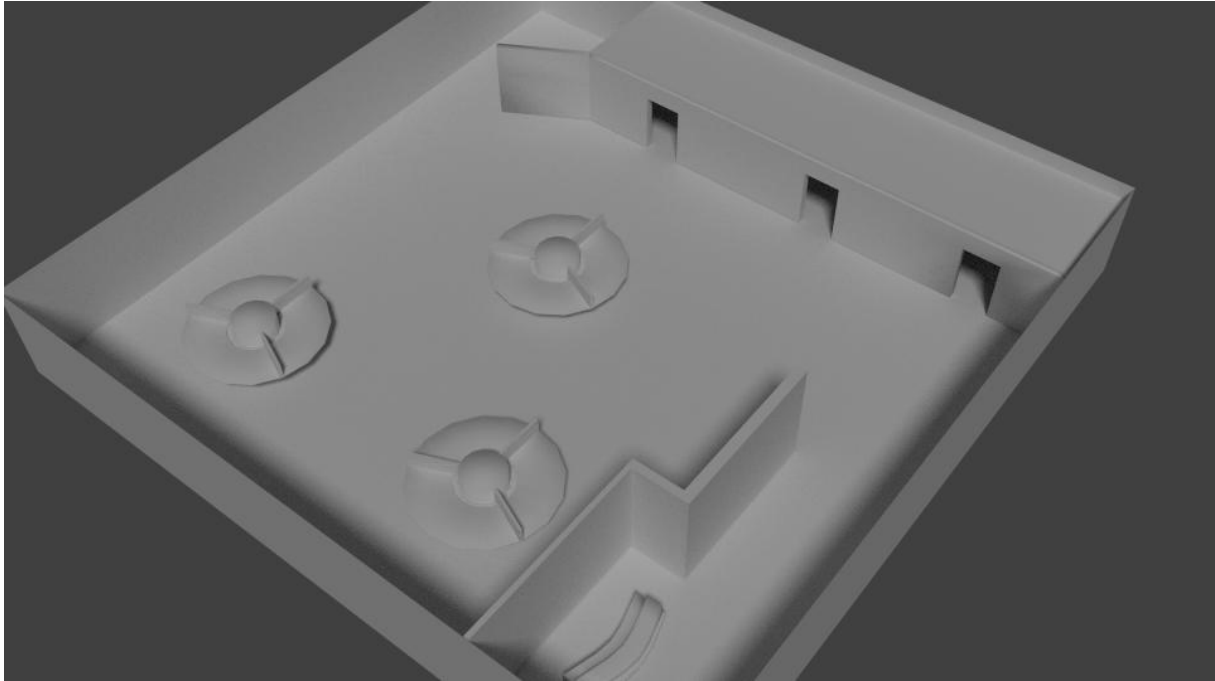


Figure 10 Screenshot from Blender3D showing Basic Office Environment

Mixamo Fuse is a standalone 3D human or humanoid character maker. It makes 3D character creation easy for this kind of projects [3]. The purpose of using Mixamo is to video game-ready character creation. This means that when a 3D object is required for a video game it needs to be having fewer amounts of polygons (or vertex, triangles, faces) because of limitations of hardware. Characters created with Mixamo are around 10k polygons that are enough for average computer to handle but it might be high for mobile usage. Inside Mixamo, the user starts character creation with deciding the gender of the character and then choosing right parts for the character. It is possible to customize the character inside Mixamo. The process of character creation is similar to ones in RPG or MMORPG games but with more control and options (see Figure 11).

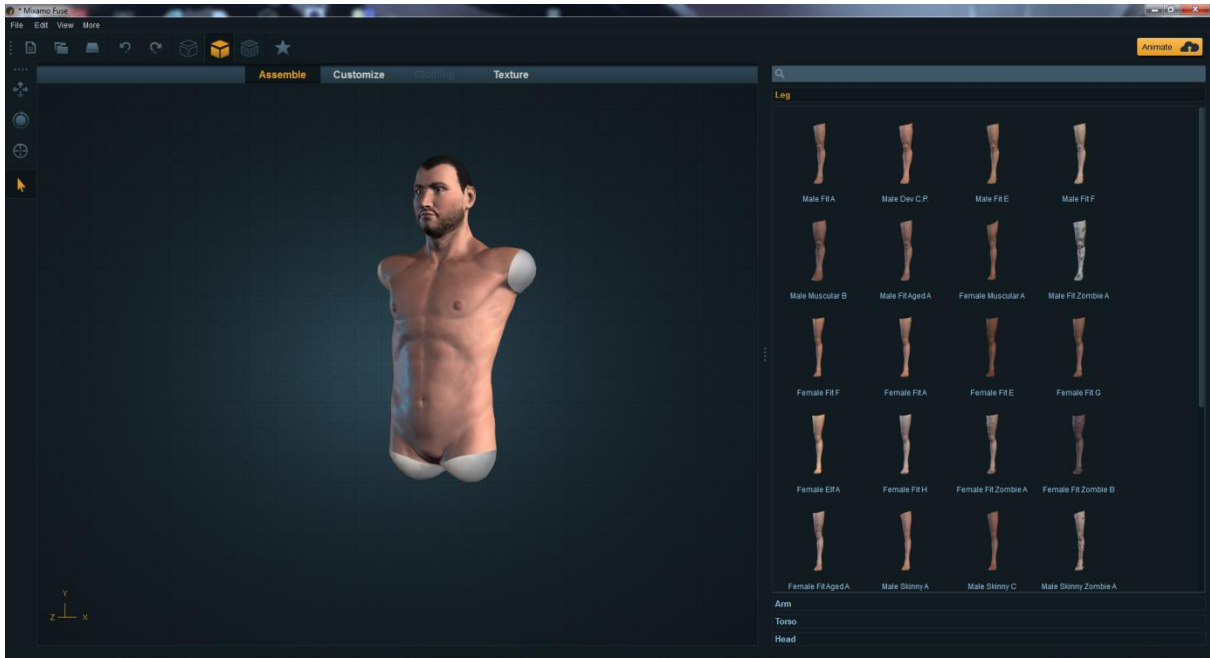


Figure 11 Screenshot of Mixamo Character Creation

When the character creation process ends, the rigging process starts. Rigging is the way of animating complex characters, like the characters used in this research. Generally, rigging is adding skeleton to 3D characters to create complex animations (see Figure 12).

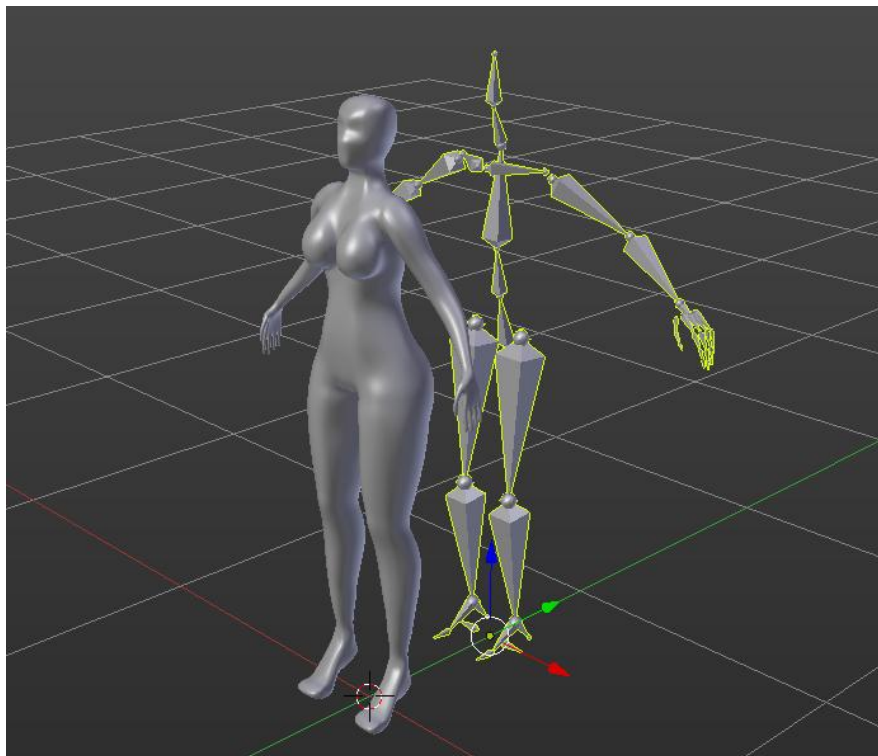


Figure 12 Screenshot of 3D Mesh and Rig (Skeleton)

Mixamo has not such application inside but it has a web-site that users can upload any 3D mesh in order to rig the character automatically. Therefore, the characters created for this project is uploaded to web-site to be rigged. After rigging phase, animations such as walk, jump etc. is required to make characters look alive. Mixamo's web-site offers numerous animations so the animations were also downloaded from this web-site. After character creation and rigging, the finalized character is exported as a .fbx file for Unity3D.

Adobe Premier Pro is a video-editing tool developed by Adobe [4]. It allows users to edit video or voice sequences easily (see Figure 13).

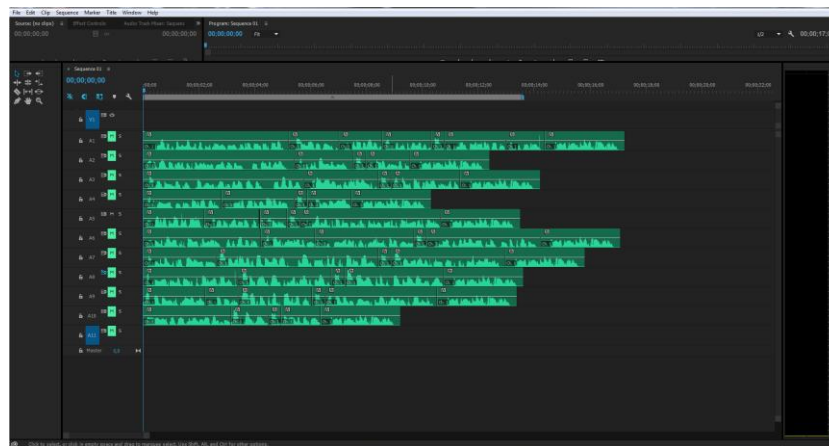


Figure 13 Screenshot that shows Adobe Premier Pro with Project Files

Premier Pro is used because each of 70 questions resides in the interactive assessment environment is sound recorded. Recording every questions and answers took more than 24 hours with the help of Hacettepe University Faculty of Fine Arts, Department of Graphic Design senior Elif İldeş. Adobe Premier Pro is used for editing those voice records to minimize the error in sound.

Unity3D is one of the popular video game engine developed by Unity Technologies [25] which it allows users to concentrate design and implementation of game and its mechanics rather dealing with technical details such as coding real world physics or rendering. It is a standalone program for 3D/2D games and simulations. Unity3D is chosen for this project because it is free and has online asset store where anyone can find anything related to making a video game. For this research, every asset created with above programs gathered inside Unity3D and with those imported assets, an office scene is created (see Figure 14).



Figure 14 Screenshot of Office Scene in Unity3D

The office scene contains base office environment from Blender, characters and animations from Mixamo, recordings of personality related questions from Premier Pro and various office props such as PC's, MAC's, office chairs, desk props and textures from Unity Asset Store. In addition, there is also a scene called "game over" when players done answering 70 - personality reveling- questions the game directs player to this scene. This scene uses only Unity3Ds UI system to present the information about participant's personality (see Figure 15).

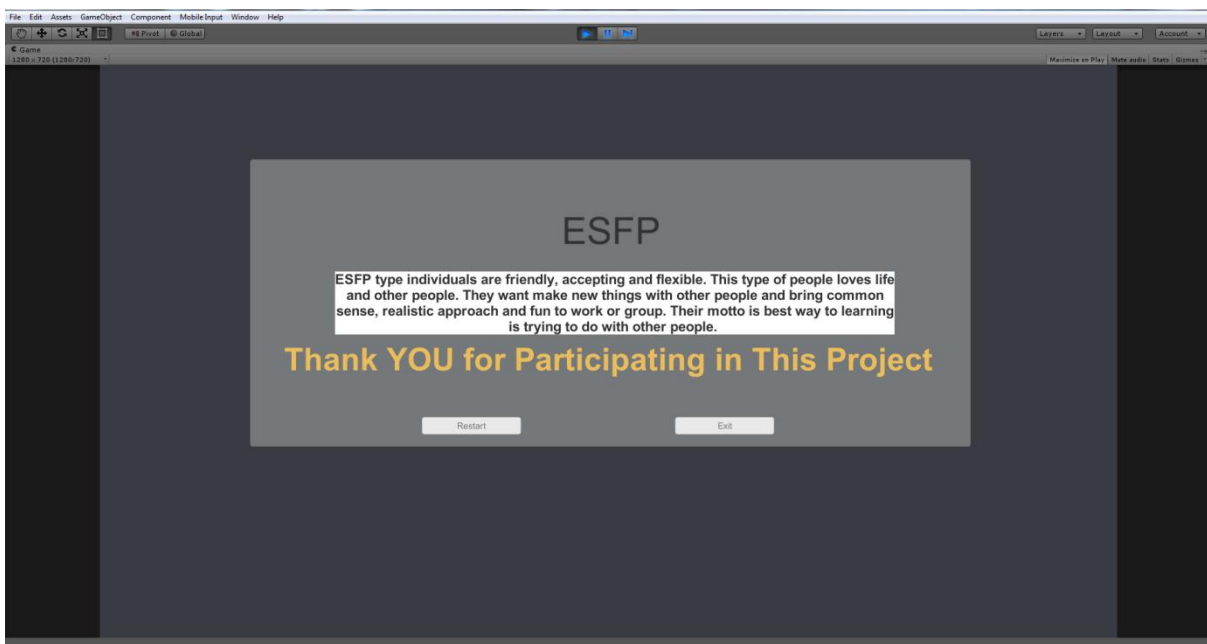


Figure 15 Screenshot of Game Over Scene in Unity3D

4.3 Game Play Data

Play data of participants was recorded by the computerized environment, which is developed for this project. The data contains answer of the participants to certain personality related questions that appear during the play. The data is written into a XML file by a script called "XMLWriter". This script takes the answers which is A or B, from the user and writes in to XML file when the in-game interview process ends (see Figure 9).

```
1 <?xml version="1.0" encoding="utf-8"?>
2 <data>
3   <Subject>
4     <ID>1</ID>
5     <ans1>a</ans1>
6     <ans2>b</ans2>
7     <ans3>a</ans3>
8     <ans4>b</ans4>
9     <ans5>a</ans5>
10    <ans6>b</ans6>
11    <ans7>a</ans7>
12    <ans8>b</ans8>
13    <ans9>a</ans9>
14    <ans10>a</ans10>
15    <ans11>a</ans11>
16    <ans12>a</ans12>
17    <ans13>b</ans13>
18    <ans14>b</ans14>
19    <ans15>b</ans15>
20    <ans16>b</ans16>
21    <ans17>a</ans17>
22    <ans18>b</ans18>
23    <ans19>a</ans19>
24    <ans20>b</ans20>
25    <ans21>a</ans21>
26    <ans22>a</ans22>
27    <ans23>a</ans23>
28    <ans24>a</ans24>
29    <ans25>b</ans25>
30    <ans26>b</ans26>
31    <ans27>b</ans27>
32    <ans28>b</ans28>
33    <ans29>a</ans29>
34    <ans30>b</ans30>
35    <ans31>a</ans31>
36    <ans32>b</ans32>
37    <ans33>a</ans33>
38    <ans34>b</ans34>
39    <ans35>b</ans35>
40    <ans36>b</ans36>
41    <ans37>a</ans37>
42    <ans38>b</ans38>
43    <ans39>b</ans39>
44    <ans40>b</ans40>
45    <ans41>a</ans41>
```

Figure 16 Screenshot of XML file with Answers obtained from interactive assessment

XML file is chosen because the answers are not complicated as address or phone number in any database and since it is formatted (see Figure 16) it can be imported easily to Microsoft Excel or other programs similar to Excel.

4.4 Summary

To sum up, this chapter is about the tools and techniques that are utilized for the development of an interactive assessment where all the tools that are selected to address the aims of this project are also discussed. In addition, the technical decisions were explained. For example, the data that is collected during the interactive assessment is stored in a XML file format to preserve the simplicity. Consequently, the stored data becomes both machine and human readable. Lastly, chapter 5 comes after this chapter and it presents the result and analysis section of this study.

Chapter 5

Result and Analysis

5.1 Introduction

This section of the research contains analysis and results of this study. Analysis part of this section presents information about the data that obtained from the participants and shows how this data is processed to obtain results.

5.2 Demographics of the Participants

This section presents frequencies of detected personality from the participants. All of the descriptive statistics related to this section is done by IBM SPSS 20 portable version.

There were 21 people who participate to this study, 16 (76.2%) of them were man, and 5 (23.6%) of them were woman. Table 5 shows frequency distribution and percentage of gender in the study.

	Frequency	Percent
Man	16	76.2
Woman	5	23.6
Total	21	100.0

Table 5 Frequency Distribution of Gender Data

In descriptive part of the study, age of the participants was asked and age information is categorized under 4 sections. The first section was "18-25" and 5 (23.8%) participants who fall in this category. The second section was "26-30" and 12 (61.9%) participants were fall in this category. Similarly, section three was "31-35" and 1 (4.8%) participant was categorized under this section. Lastly, fourth section was ">40" (older than 40) and 2 (9.5%) participants were fall in this section. Table 6 shows frequency distribution and percentage of age data of this study.

Age Category	Frequency	Percent
18-25	5	23.8
26-30	13	61.9
31-35	1	4.8
>40	2	9.5
Total	21	100.0

Table 6 Frequency Distribution of Age Data

In last part of the descriptive statistics, education status of the participants was asked. Among this 21 participants 1 (4.8%) of them were "High School" graduate, 16 (76.2%) of them were "University" graduate and 4 (19.0%) of them were "Master's Degree" graduate. Table 7 shows frequency distribution and percentage of education status of participants of this study.

Education Status	Frequency	Percent
High School	1	4.8
University	16	76.2
Master's Degree	4	19.9
Total	21	100.0

Table 7 Frequency Distribution of Education Data

Although, education status scale contains primary school, junior high and doctoral degree, the output is omitted because there were no data for these choices.

The personality of participants were also recorded by paper based assessments and in-game assessment (See Appendix D). The personality data obtained from 21 participants via both of the assessment methods resulted that; 3 (14.3%) ENFJ, 2 (9.5%) ENFP, 3 (14.3%) ENTP, 2 (9.5%) ESFJ, 1 (4.8%) ESTJ, 1 (4.8%) ESTP, 4 (19.0%) INFJ, 3 (17.6%) INFP and 2 (11.8%) ISFP. Table 8 shows frequency distribution and percentage of detected MBTI personality of participants of the study. Similarly, table 9 shows distribution of personality into categories defined by Keirsey temperament sorter.

Detected Personality	Frequency	Percent
ENFJ	3	14.3
ENFP	2	9.5
ENTP	3	14.3
ESFJ	2	9.5
ESTJ	1	4.8
ESTJ	1	4.8
INFJ	4	19.0
INFP	3	14.3
ISFP	2	9.5
Total	21	100.0

Table 8 Frequency Distribution of Personality Data

Temperament	Frequency	Personality Pair
The Artisan	3	SP (sensing-perceiving)
The Guardian	3	SJ (sensing-judging)
The Idealist	6	NF (intuition-feeling)
The Rational	2	NT (intuition-thinking)

Table 9 Frequency Distribution of Keirsey Temperament

5.3 Scoring the Questionnaire

A straightforward approach has used to score the questionnaire. Since the questionnaire was a 5-point likert scale from "*strongly disagree*" (value = 1) to "*strongly agree*" (value = 5) values of each element were summed to reach a result (See Appendix C). However, the questionnaire were containing 2 negative questions (question 3 and 5) so for those questions the scale were reversed ("*strongly disagree*" (value = 5) to "*strongly agree*" (value = 1)) to avoid statistical error. There were 12 questions in the questionnaire so the highest score is 60 whereas lowest score is 12 and the mid score is 36. Table 10 shows data entries of first and second survey scores.

FirstSurveyScore	SecondSurveyScore
28	50
34	42

42	58
36	42
53	54
47	51
32	48
41	47
50	51
37	48
37	48
26	44
32	46
50	56
40	46
29	51
36	47
47	52
45	47
36	48
41	50

Table 10 Calculated Survey Scores of Participants

5.4 Analysis of Obtained Data

The purpose of this research is to observe the more positive experience that users of the interactive game assessment receive over paper-based version. In order to test this, the participants were took the modified version of game-play scale twice. Since, a participant was tested twice paired sample t-test or t-test for two related samples required to make the analysis [37]. In this context, the hypothesis of the research;

H₀: The experience that the participants receive from both of the assessment methods has no difference.

H₁: The experience that the participants receive from both of the assessment methods has a difference.

In order to calculate paired sample t-test IBM SPSS 20 portable version is used. For this test, level of significance selected as 0.05 (95%) ($\alpha=.05$). Since there were 21 participants the degree of freedom calculated as 20 ($df = n - 1$). Hence, the critical value is ± 2.080 . In light of these, paired sample t-test calculated as 7.131 ($t = 7.131$). Since the calculation of paired samples t-test were done using a computer, the significance level were calculated as .0000 ($p=.000$), the probability was so small that computer rounds the number into .0000. In situation like this, [37] states that the probability value should be written as $p<.001$.

The calculated t-test indicates that the null hypothesis (H_0) is rejected and according to [37] Cohen's d and percentage of variance (r^2) are required for calculating the effect size. For paired sample t-test, Cohen's d formula is [37];

$$\text{estimated } d = \frac{\text{sample mean difference}}{\text{sample standard deviation}} = \frac{MD}{s}$$

M_D part of the formula is calculated as difference between "second survey score" and "first survey score" over sample size (n).

$$MD = \frac{\text{Difference}}{\text{sample size}} = \frac{\Sigma D}{n}$$

Table 11 shows difference of second and first survey and scores of both surveys.

FirstSurveyScore	SecondSurveyScore	Difference of Survey Scores
28	50	22
34	42	8
42	58	16
36	42	6
53	54	1
47	51	4
32	48	16
41	47	6
50	51	1
37	48	11
37	48	11
26	44	18
32	46	14
50	56	6
40	46	6
29	51	22
36	47	11
47	52	5
45	47	2
36	48	12
41	50	9

Table 11 Calculated Survey Scores and Difference of Calculated Scores

So the M_D is calculated as 9.85 ($M_D = 9.85$) and standard deviation calculated as 6.335 ($s = 6.335$) because of these Cohen's d is resulted as 1.55 ($d = 1.55$). According to Cohen's d any value greater than 0.80 is considered to be large effect [37]. Since it is calculated that the d equals 1.55 the effect size of this study is large.

The formula for percentage of variance (r^2) is;

$$r^2 = \frac{t * t}{(t * t) + df}$$

Therefore, r^2 is calculated as 0.70 (70%) and r^2 states that any value greater than 0.25 is considered as large effect. Similar to Cohen's d the obtained data shows very large effect size.

Alternative to paired sample t-test there is another test called Wilcoxon test, which uses data obtained from same subjects to observe difference between two specific conditions [37].

Parameter for Wilcoxon test were the same as the paired sample t-test above (level of significance ($\alpha=0.05$)). Therefore, just like the results of the paired sample t-test, Wilcoxon test were also states that the null hypothesis of this research required to be rejected because $p<.0001$.

5.5 Threats to Validity

There are some threats that can cause poor quality of results but in this study, threats were intend to be reduced at minimum. Despite of this, there are threats that can still affect the results. The threats for this study are listed as;

- History or time between the surveys can cause a threat. However, this threat poses no danger to the study since the surveys were done in the same day.
- Background of the participants may affect the results but demographics of age and educations status show that participants of the study have the similar background. Hence, the participants were randomly selected from software developers.
- Instrument, which is survey, in this case can also pose a threat to validity. In order to avoid this problem, a survey scale is adopted and modified to fit the both of the assessments.
- Although, strictly warned the participants may make mistake while scoring the survey.
- Number of participants can pose a threat to validity. It is stated in [37] that paired sample t-test requires fewer participants than an independent sample t-test. However, [37] also states that in situations where number of participants less than 30, validity of the study can be compromised. In order to eliminate this statement, the data gathered from participants must be normal (Assumption of Normality) [37]. Since the study utilizes paired sample t-test, the difference of survey scores must be normal. In order to prove the data as normal, Kolmogorov Smirnov and Shapiro Wilk test conducted on the difference of survey scores in SPSS [53]. Respectively, results of the both test

shows that significance values (p) are 0.189 and 0.260. Since the level of significance selected as 0.05 (95%) ($\alpha=0.05$) and the results obtained from both of the test is greater than $\alpha=0.05$, for this study number of participants pose no threat to validity [53].

5.6 Validation Interview

In order to support the findings of quantitative data, validation interviews for interactive assessment environment were also conducted. In these interviews, 3 questions are asked to experts to receive opinion about the interactive assessment. The questions are listed as follows;

Question 1: What do you think about the generic functionalities of software product?

Question 2: What kind of improvements would you suggest?

Question 3: Do you think there is/are advantages of interactive assessment environment over paper-based assessment?

For the first question participants of validation interview overall stated that the software product does help to reveal the personalities of software practitioners so this helps to reduce the problems that "human factor" causes. In addition, the software product is useful to software team forming and it does help to improve the software development processes when the personalities of practitioners are in consideration. In fact, one of the participants of the interview stated that *"The software product maintains the general activities of finding the true route of personality test and has a potential to compose more interactivity to expose to the user"*. However, they also mentioned that some bugs or mistakes that the software product resides such as some buttons were do not work or the problems with sound records etc...For improvements, *"There should be continuously improvement in interactive assessment environment to engage users,..."* and they mentioned that repetitive nature of the interactive assessment needs to be altered to avoid being boring and the time that takes to complete the interactive assessment needs to be adjusted for the same reason. Some of the participants mentioned that the graphics or the visuals requires improvement and background music along with new sound effects and new ways of interactivity should be added to the interactive assessment environment. Lastly, depending on the release of the product the mobility or mobile support of the interactive environment can be considered as an advantage. One of the interviewees stated that *"Based on the ambition, which is maintained by the software product,*

helps to make advantageous points over the paper based version certainly. One of them - probably the most obvious and important- one is that creating a graphical environment for the user to involve the activity rather than traditional reading and filling a survey". In addition, the feedback mechanism, the visual and the sound elements reside in the software product seem to be considered as an advantage by the interviewees.

5.7 Summary

To conclude, this chapter contains information about the demographics and analysis related to the obtained data from participants. Detailed information of participants' demographics such as frequency distribution and percentage of distribution in overall sample size is exists in this chapter. This chapter also has the details about the analysis of paired sample t-test, Cohen's d, percentage of variance and Wilcoxon for test the hypothesis and measure the effect size of the research. Results obtained from paired sample t-test states that there is significant difference between the means of first and second survey. The next chapter of this study is the conclusion and future works related to the thesis.

Chapter 6

Conclusion and Future Work

The main purpose of this research was to propose an interactive approach to reveal personality of software practitioners. Consequently, it addressed problems that can cause by personality type incompatibilities to improve the quality of team formation in software development. Literature review indicated that the software development process has various challenging tasks that developers need to tackle. These tasks however can become more complex because of the human factors. Therefore, an interactive assessment environment was designed to lift some of the burden from software developers. The analysis showed that there is significant difference between the results of first survey and the second. This indicates that the proposed method works as it was intended. Furthermore, similar to the results of the analysis, the validation interviews also indicate that the interactive personality assessment environment is helpful to improve the software development processes by revealing personalities of software practitioners. Although, this marks the end of this research there are still various improvements should be done as a future work. The proposed method, in its current state can be seen as a prototype of a software product. Like many other software products that released or developed, it has some deficiencies. The survey showed that in some cases participants were disagree or neutral about the survey question 3 for interactive assessment version. This situation was also mentioned in the validation interviews. This shows that interactive assessment lacks of "fun factor" that other games have. Although, the interactive assessment categorized in simulation genre "fun factor" still exists. In order to overcome this, future releases require new implementations for the interactive assessment. Future releases will have new;

- Environments with more interactivity.
- Theme based animations, graphics and sound.
- Questions to reveal personality.
- Ways to make the personality test. Rather than asking directly, the questions can be embedded into a story.

In addition, the time required to complete the interactive assessment needs to be adjusted well to avoid being repetitive and boring according to validation interviews.

The current state of the interactive assessment environment runs only on desktop computers. Mobile release of the system can reach more people to gather more data. However, in a possible mobile release the interactive assessment requires optimization to work on mobile devices because mobile devices have less computational capability than today's computers. In order to optimize the developed assessment environment;

- The every 3D model including characters required to have fewer polygons to work on a mobile platform. To achieve this, 3D models in the interactive assessment required to be modeled again with fewer polygons.
- Frames of animations in the interactive assessment might require being less than the current form for mobile platforms.
- Some optimization techniques used by big budget games such as voxelization⁵ and occlusion culling⁶ that may require to be used in the interactive assessment environment.
- Lastly, a possible addition of new characters, environments, animations, etc... Need to be created with the consideration of mobile involvement.

During this study, new technologies continued to emerge and some of them such as virtual reality (VR) are noted for future improvements. Virtual reality became a huge phenomenon in recent years and poses great potential for scientific research as well as being a new video game technology. This new technology allows control of virtual environments without restraining the users with conventional controllers like gamepads, keyboards, etc...

⁵ Voxelization is a technique of transforming 2D or 3D data into voxel data for achieving better render results.

⁶ Occlusion Culling is a technique of changing the rendering option of 3D object when camera frustum is not looking at that specific object for better performance.

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Part 1

Appendices

Appendix A

Survey Instrument

Hello! My name is Mert YILMAZ and I'm a Masters Degree student at Çankaya University Department in Computer Engineering. As part of my thesis, an interactive personality assessment environment has been created to reveal the personality types of software practitioners.

To achieve result through certain analysis the questionnaire below required to be filled by the participants of the research. The questionnaire will be filled by all of the participants and the answers that given for the questions and result that will be derived from the answers will be confidential to third-parties. No name is required from participants to fill in so please take a few moments to fill out the survey. It should take approximately 10 minutes to complete the survey. Please carefully read all of the questions that on the survey and answer the questions accordingly. Please do not hesitate the mention your concern or problem during the study.

Cinsiyetiniz	Erkek	Kadın				
Yaşınız	18-25	26-30	31-35	36-40	40 üzeri	
Eğitim Durumu	İlkokul	Ortaokul	Lise	Lisans	Yüksek Lisans	Doktora
	Kesinlikle Katılmıyorum	Katılmıyorum	Emin Değilim	Katılıyorum	Kesinlikle Katılıyorum	
1. Benim için yaşadığım deneyim olumluydu						
2. Sorulara kolayca yoğunlaşabildim						
3. Değerlendirme yönteminin sıkıcı olduğunu düşünüyorum						
4. Değerlendirme sırasında yapacaklarım belirliydi						
5. Soruları anlamada güçlük çektim						
6. Bu uygulamaya benimle ilgili bir takım bilgileri ortaya çıkarttı						
7. Uygulama yönteminin etkileşimli olduğunu düşünüyorum						
8. Genel olarak testi cevaplamak kolaydı						
9. Uygulama sırasında deneyimlediklerimin yeterli olduğunu düşünüyorum						
10. Uygulama beni daha fazla ilerlemem için yönlendirdi						
11. Uygulama sırasında ne yapacağımı her zaman biliyordum						
12. Estetik açısından uygulama yeterliydi						

Gender	Male	Female				
Age	18-25	26-30	31-35	36-40	Above 40	
Education	Primary School	Junior High	High School	University	Master's Degree	Doctoral Degree
	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree	
1. The experience I had was positive						
2. I was able to concentrate on questions easily						
3. I think the assessment was boring						
4. What was going to do during the assessment was clear.						
5. I have struggled to understand the questions						
6. The assessment revealed some information about me						
7. I think that the assessment management was interactive						
8. Generally the test was easy to answer						
9. I think that what I had experience during the assessment was satisfactory						
10. The assessment guided me to proceed forward						
11. I always knew what to do during the assessment						
12. Aesthetically, the assessment was satisfactory.						

Appendix B

	a	b		a	b		a	b		a	b		a	b		a	b		a	b
1			2			3			4			5			6			7		
8			9			10			11			12			13			14		
15			16			17			18			19			20			21		
22			23			24			25			26			27			28		
29			30			31			32			33			34			35		
36			37			38			39			40			41			42		
43			44			45			46			47			48			49		
50			51			52			53			54			55			56		
57			58			59			60			61			62			63		
64			65			66			67			68			68			70		
E/I						S/N						T/F						J/P		

The Scoring

1- Write the answer to the corresponding cells. After that sum the all a's or b's in corresponding cells and write the number of a's or b's at the bottom of the table.

2- In order to decide E/I letters just check the numbers of a's or b's in corresponding cell. For other letters add the results of the previous cells.

3- If the numbers of a's and b's are equal then the put X instead of any letter above and reveal the specifics of the possible personality to individuals to allow them to choose the suited personality.

	a	b		a	b		a	b		a	b		a	b		a	b		a	b
1		x	2		x	3		x	4		x	5		x	6		x	7		x
8	x		9	x		10	x		11	x		12		x	13	x		14		x
15	x		16		x	17		x	18		x	19		x	20	x		21	x	
22		x	23	x		24		x	25		x	26		x	27		x	28	x	
29		x	30	x		31	x		32		x	33		x	34	x		35	x	
36		x	37		x	38		x	39	x		40		x	41	x		42		x
43		x	44		x	45	x		46		x	47	x		48	x		49		x
50		x	51	x		52	x		53		x	54		x	55	x		56	x	
57		x	58	x		59	x		60	x		61		x	62	x		63	x	
64	x		65		x	66	x		67	x		68		x	69		x	70	x	
E/I	3	7		5	5	S/N	6	5		4	6	T/F	1	9		7	3	J/P	6	4

Personality = ISFJ

$$E/I = 3a < 7b = I$$

$$S/N = (5a+6a) > (5b+5b) = S$$

$$T/F = (1a+4a) < (6b+9b) = F$$

$$J/P = (7a+6a) > (3b+4b) = J$$

Appendix C

Survey Data

1	Participant	SQ1	SQ2	SQ3	SQ4	SQ5	SQ6	SQ7	SQ8	SQ9	SQ10	SQ11	SQ12
2	1	5	5	1	2	1	5	3	4	4	3	2	3
3		5	5	1	2	1	5	5	4	4	3	3	5
4	2	3	2	5	3	2	3	2	4	3	3	3	1
5		4	4	3	4	1	4	5	4	4	4	4	5
6	3	4	2	3	3	3	4	3	4	5	4	2	4
7		5	3	1	3	3	4	4	4	5	4	2	5
8	4	4	4	2	5	1	4	3	4	4	2	5	4
9		4	5	1	4	2	4	5	5	4	2	4	5
10	5	4	3	4	3	2	4	2	4	3	3	3	2
11		4	5	2	4	2	3	5	4	3	4	4	4
12	6	3	2	4	4	4	4	2	4	3	4	4	3
13		4	4	2	4	3	4	4	4	4	4	5	4
14	7	3	3	5	4	4	3	2	4	3	2	4	2
15		5	5	2	4	2	4	4	4	4	4	4	5
16	8	3	4	4	4	2	2	2	4	4	3	4	4
17		4	4	2	5	2	2	4	4	4	4	4	4
18	9	4	3	2	2	2	3	4	4	3	2	3	4
19		4	3	2	4	2	4	4	4	3	4	4	4
20	10	5	4	2	5	2	4	3	5	4	4	3	5
21		5	4	3	5	3	4	5	5	4	4	5	5
22	11	3	2	4	4	4	4	2	3	2	3	3	2
23		4	4	2	4	4	4	4	4	3	3	4	4
24	12	4	2	4	4	4	3	2	1	3	1	2	2
25		4	4	2	4	2	4	4	3	3	4	2	4
26	13	5	4	3	5	1	5	4	5	4	5	5	3
27		5	4	3	5	1	5	4	5	5	5	5	3
28	14	3	4	3	4	2	3	2	4	2	2	3	2
29		3	4	3	4	2	3	4	4	3	2	4	4
30	15	5	4	2	3	2	5	2	3	4	4	3	1
31		5	5	1	4	1	5	5	5	4	5	5	5
32	16	3	2	3	4	4	4	1	4	2	2	5	2
33		4	3	3	4	2	4	4	4	3	3	4	3
34	17	2	3	5	4	4	4	1	4	1	1	4	1
35		5	4	4	5	2	4	5	4	4	4	4	5
36	18	5	3	5	5	2	4	4	4	4	4	4	5
37		5	5	1	5	2	5	5	4	4	5	4	5
38	19	4	3	3	4	5	4	4	4	4	4	4	5
39		5	3	3	4	5	5	4	4	4	4	4	5
40	20	3	2	4	4	4	4	1	4	3	4	4	3
41		4	4	2	4	3	4	4	4	4	4	5	4
42	21	4	2	3	3	3	4	3	4	5	4	2	4
43		5	4	4	5	2	4	5	4	4	4	4	5

Appendix D

Personality Test Data

ID	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10	Q11	Q12	Q13	Q14	Q15	Q16	Q17	Q18	Q19	Q20	Q21	Q22	Q23	Q24	Q25	Q26	Q27	Q28
1	b	a	a	a	b	a	a	a	b	b	a	b	b	a	b	b	b	a	a	b	a	b	b	b	b	a	a	a
2	b	a	b	b	b	a	a	a	a	a	a	b	a	a	a	a	a	b	b	a	b	a	b	b	b	a	a	a
3	a	a	b	b	a	b	b	a	b	a	b	a	a	a	a	b	b	a	a	b	a	b	a	b	b	b	b	b
4	b	b	b	b	b	a	b	b	b	a	a	b	a	a	b	b	b	a	a	b	a	a	b	b	b	a	b	a
5	a	a	b	b	a	b	b	a	b	b	b	a	b	a	a	b	b	b	b	b	b	a	a	a	a	b	b	a
6	a	b	a	a	b	a	a	a	b	b	a	b	a	a	a	b	a	b	b	b	a	a	a	b	b	b	a	a
7	a	b	a	a	b	b	b	b	b	b	b	a	b	b	a	b	b	a	a	b	b	b	b	b	a	b	a	a
8	a	b	a	b	b	b	b	a	b	a	a	b	b	b	b	b	b	b	b	b	b	b	b	b	b	b	a	a
9	a	a	a	b	b	b	b	a	a	a	b	b	b	a	b	a	a	a	b	a	b	a	b	a	b	a	b	a
10	a	a	b	a	b	b	b	b	b	a	a	b	a	a	b	b	a	a	a	b	b	b	b	b	b	a	b	a
11	a	a	b	b	b	b	b	b	a	a	a	b	b	b	a	b	b	b	a	b	a	b	a	b	a	b	b	a
12	b	a	b	b	b	b	b	b	a	a	a	a	b	b	b	b	a	a	b	b	a	b	a	a	b	a	a	a
13	a	b	a	b	a	b	b	a	b	a	a	a	b	a	b	b	b	b	b	b	b	a	b	b	a	a	b	a
14	a	b	a	b	b	b	a	a	b	b	a	b	a	a	a	a	a	a	b	a	b	a	a	b	b	a	a	a
15	a	b	b	b	b	a	b	b	a	b	b	a	b	a	a	b	b	a	b	b	b	a	b	b	b	b	b	a
16	b	a	a	b	b	a	a	a	a	b	b	b	a	b	a	b	a	b	a	b	a	b	a	a	a	b	b	b
17	b	a	a	b	b	a	b	a	b	b	a	b	b	a	b	b	a	a	b	a	a	a	b	b	b	a	b	b
18	b	b	b	b	a	a	b	b	b	a	a	a	b	b	b	b	b	b	a	a	a	b	a	a	b	b	b	b
19	b	b	b	a	a	b	b	b	b	b	b	a	b	b	b	b	b	b	b	b	b	b	b	b	b	a	a	b
20	a	a	b	a	a	a	b	b	b	b	b	a	b	a	b	a	a	a	a	b	b	a	b	a	a	a	a	b
21	b	b	b	b	b	b	b	a	a	b	a	b	a	b	a	b	b	b	b	a	a	b	a	b	b	b	b	a

Q29	Q30	Q31	Q32	Q33	Q34	Q35	Q36	Q37	Q38	Q39	Q40	Q41	Q42	Q43	Q44	Q45	Q46	Q47	Q48	Q49	Q50	Q51	Q52	Q53	Q54	Q55	Q56	Q57
a	a	a	b	b	a	b	b	a	b	a	a	a	a	b	b	a	a	a	a	b	b	a	a	b	b	a	b	b
b	b	a	a	b	a	a	b	a	b	a	b	a	a	b	a	b	b	a	b	a	b	a	a	b	b	a	a	b
a	b	b	b	a	b	a	a	a	a	a	a	a	a	b	b	a	b	a	a	a	b	a	a	a	b	a	b	b
a	b	b	b	b	b	a	b	a	a	a	a	a	b	b	a	b	a	b	a	a	a	b	a	a	b	b	a	b
a	b	b	b	b	a	b	a	b	b	a	b	b	a	a	b	a	a	a	a	a	a	a	a	a	b	a	a	a
a	b	a	b	b	b	a	b	a	a	a	b	b	b	a	b	b	b	b	b	a	a	a	a	a	b	b	b	a
b	b	a	b	b	a	b	b	a	a	b	a	a	b	a	b	a	b	a	a	a	a	b	a	b	a	b	a	b
b	a	b	b	b	b	a	b	a	b	a	b	a	b	b	b	a	b	a	a	a	a	b	a	b	a	b	b	b
b	a	b	a	b	b	a	b	a	b	a	b	a	b	b	b	a	a	a	a	a	b	a	b	a	b	a	b	b
b	a	b	b	b	a	a	b	b	a	a	b	a	b	b	b	a	b	a	a	a	a	b	a	b	a	b	b	a
a	a	b	b	a	a	b	a	b	a	a	b	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a
a	b	b	b	b	a	a	b	a	b	a	b	a	a	a	a	a	b	a	a	a	b	b	a	b	b	b	b	a
a	b	b	a	a	b	a	a	a	b	a	b	a	b	a	a	a	a	a	a	b	b	a	b	b	a	a	b	a
a	b	b	a	a	b	a	a	a	b	a	b	a	b	a	a	a	a	a	a	b	b	a	b	b	a	a	b	a
b	b	b	a	b	b	a	b	a	b	a	b	a	b	b	a	a	a	a	a	b	b	a	b	b	a	a	b	a
a	a	a	a	a	a	b	a	b	a	b	a	b	b	a	a	a	b	a	a	a	a	a	a	a	a	a	a	a
b	a	a	b	b	b	a	b	b	a	b	b	b	b	b	b	b	b	b	b	b	b	b	b	b	b	b	b	a
b	a	a	b	b	b	a	b	b	a	b	b	b	b	b	b	b	b	b	b	b	b	b	b	b	b	b	b	a
a	b	a	a	a	a	b	a	b	a	b	a	b	b	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a
b	b	b	a	a	b	a	b	b	a	b	a	b	a	b	a	a	a	a	a	b	b	a	b	b	a	a	b	a
a	a	a	a	b	a	a	a	b	a	b	b	a	b	b	a	a	a	a	a	a	a	a	a	a	a	a	a	b

Q58	Q59	Q60	Q61	Q62	Q63	Q64	Q65	Q66	Q67	Q68	Q69	Q70
a	b	b	b	b	b	b	b	a	b	b	b	a
b	a	a	b	a	a	a	b	a	a	b	a	a
a	a	a	b	a	b	a	b	a	a	b	b	a
a	b	a	b	b	a	a	a	b	b	b	b	a
b	b	a	b	b	b	b	a	b	a	b	a	b
b	a	a	b	b	b	a	a	a	b	b	a	a
a	b	b	a	b	b	a	b	b	b	b	b	a
b	b	a	b	a	b	b	b	a	a	b	b	b
b	b	b	b	b	b	a	b	a	b	b	b	a
b	b	b	b	b	b	a	b	a	b	b	a	b
b	b	b	a	b	b	a	a	a	b	b	b	a
b	b	a	a	b	b	a	b	b	a	b	b	a
a	a	a	a	a	b	a	b	a	b	b	a	b
b	b	a	b	b	b	a	b	a	a	b	a	a
b	a	a	b	b	b	a	b	b	b	b	b	a
b	a	a	b	b	b	a	b	b	b	b	b	a
b	a	a	b	b	b	b	b	a	b	b	b	b
b	a	b	b	b	b	a	b	b	b	b	b	a
a	b	a	a	a	b	a	b	a	b	b	a	b
b	b	b	a	b	b	b	a	a	b	a	a	b
a	a	a	b	a	a	a	b	b	a	b	b	a