A Gamification Approach to Improve the Software Development Process by Exploring the Personality of Software Practitioners

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Abstract. 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 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 specifically designed for software engineers. Based on the developed tool, a study was 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 versions of the same assessment. The analysis of this 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 types are in consideration.

Keywords: Software process improvement, team process, gamification, interactive assessment, personality

1 Introduction

Software engineering is a discipline that encompasses a systematic design, production and maintenance of a software product. Development of new technologies, software and hardware improvements and affordable technological devices made this field of business more valuable. As new technologies emerge, branches inside software development started to blossom e.g. web development, embedded system development, etc. Video game development is one of those branches 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.

The popularity of game industry has pioneered new approaches such as gamification. Gamification is a new field of research, which can improve any business process by adding game elements in a non-game context [1]. Gamification relies on autonomy of an individual as well as the experience that is captured in video games [2]. For this reason, through gamification it is possible to have people to participate in certain activities e.g. taking a poll or quiz. In addition, gamification and video games have also assisted 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 [3]. From its origin to today, personality is still a valid social construct [4]. Today, personality types are mostly used on job interviews. 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 [4]. 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 [5]. Therefore, in this study the MBTI-like approach is utilized 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 traditional personality assessments (e.g. extra costs and an effort to complete).

2 Background

2.1 Definition of Personality

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 [4]. Types are a rating system that based upon observations on emotional and behavioral patterns as well as experiences and preferences of an individual [6]. Personality types have different opposite four bipolar categories that classify a person, from this a set of categories (e.g. an individual cannot be both consecutively) personality prediction seems possible as research indicates that personality types are unique defining characteristics of personality [7]. Therefore, personality refers to a significant form of information about an individual's social characteristics.

The situation leads to various definitions of personality among the literature. Funder [8] states that personality is the combinations of psychological mechanism and a person's characteristic patterns of thought, behavior, and emotion. In addition, Larsen and Buss [9] describe personality as a set of psychological types and mechanism of a person that are organized by interactions of intrapsychic[4] , physical and social environ-

[4] A psychological term referring to systematic thinking of the individual within mind or psyche

ments. Pervin et al. [10] refer personality as an individual's characteristics clarified by certain patters such as feeling, thinking, and behaving.

2.2 The 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. Jung's theory of personalities consists of 8 personalities (two attitudes paired with four mental functions) [11]. 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 identifying an individual's personality type [5]. MBTI has four dichotomous pairs as shown in Table 1.

Extroversion (E)	(I) Introversion
Sensing (S)	(N) iNtuition
Thinking (T)	(F) Feeling
Judgment (J)	(P) Perception

Table 1: *Dichotomies (the four opposite pairs of preferences)*

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. 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.

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.

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.

Combination of these 4 different dichotomous pairs creates 16 different types of personalities and each of 16 different types namely; ISTJ, ISFJ, INFJ, INTJ, ISTP, ISFP, INFP, INTP, ESTP, ESFP, ENFP, ENTP, ESTJ, ESFJ, ENFJ and ENTJ.

2.3 Definition of a Game and Gamification

Games are essential part of human existence as well as ancient as human history [2]. Yet the controversies occur when one tries to seek the definition of games. Clark [12] defines games as an activity that having two or more participants to achieve certain goal using decision making. He then goes deep and adding games are activities within

certain rules that adversaries trying to win or achieve a goal. Costikyan [13] 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 [14] defines games as a voluntary effort to get through unnecessary/artificial obstacles. Similarly, Avedon et al. [15] 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 disequilibral outcome. At this point, it is clear that games have many things in common, e.g. voluntarism, predefined rules and goals, and an artificial conflict. Salen and Zimmerman [16] 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 or her effort such as score or rating. 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 [17].

Gamification is a newly introduced area of research that combines certain elements of games to create an expression between rewards and games [18]. It is firstly introduces at 2008. However, it has become notable in 2010 [19]. Although, gamification has been introduced recently in many businesses domains, have been using gamification for a long time e.g. employee of the month, flight miles, etc.

Gamification has various types of definitions and the variety of definitions creates confusions between similar but different concepts like serious games [20]. The variety of definitions is also causing incompetent design and implementation of gamification [21]. The purpose of gamification is to engage and motive the people by combining intrinsic behavior with extrinsic reward such as points, badges, and leaderboards [22]. Intrinsic behavior is the drive for to do something without an external reason, and extrinsic reward is tangible re-ward that visible to everybody [18]. For instance, loyalty rewards that airlines and hotels providing to customers. 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. Thus, this indicates that game which has all of the game elements, cannot be involved to be gamification process. Therefore, gamification is defined as a process of integrating game elements (badges, scores) into non-game context in order to create motivation and engagement [18, 22].

To date, a number of studies have demonstrated that gamification is an important asset to improve the software development process [23, 24].

3 Methodology

This study aimed to identify personality types of software practitioners by using a computer-based interactive assessment tool, which was developed to conduct this study. Based on a previous research [25], the personality types were extracted and the results was presented by using the MBTI typology. Our objective was to explore the usability of the proposed game-based approach. Next, results will be reviewed and the difference between a paper-based test and an computer-based version was analyzed.

The descriptive statistics and game play scale were used to conduct this study. In addition, we asked gender, age, education level of participants demonstrating demographics of individuals.

Game play scale [26] is a 5-point likert scale consists of 12 questions such as ”I like the graphics in the game” and modified for both assessments to be able to rate the both of them. 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”.

3.1 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 [25]. The personality related questions that were used in this interactive assessment was obtained from previous research [25], which aims to utilize a content specific (paper-based) personality revealing approach especially for software practitioners

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. 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. This set of methods contains ways such as interviewing, eye tracking and surveying, etc.

In this context, survey study was chosen for this research and Game-play scale 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.

Figure 1 shows the steps of the procedure.

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 game play scale to rate the experience they have while filling the paper version of the assessment.
3. 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.
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.

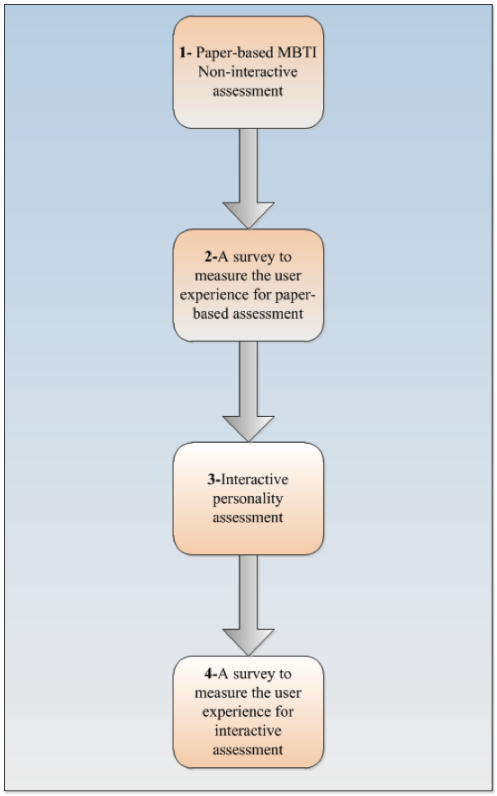

Fig. 1: *The research process*

3.2 Interactive Assessment

The 3D interactive assessment environment has two main scenes, i.e. office and game over scene. It contains an 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. Figure 2 shows a screen-shot from the interactive assessment.

In conversation, the non-playable character 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. 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. When the all of

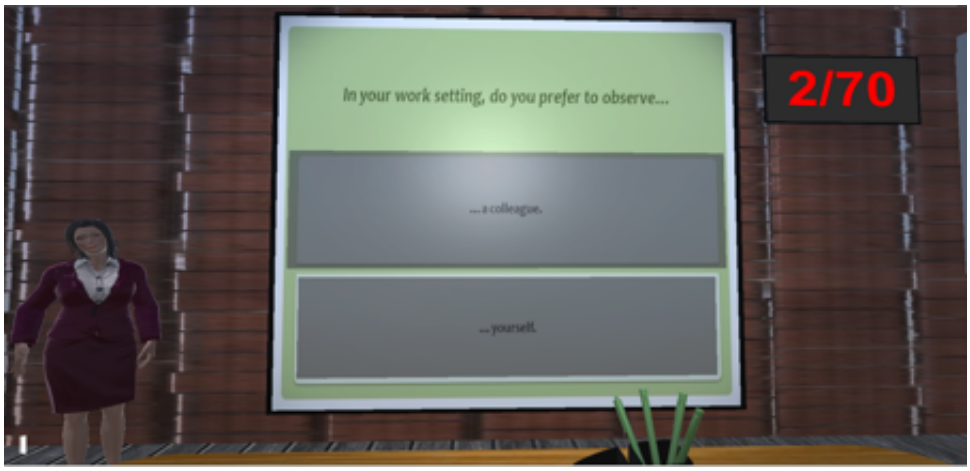

Fig. 2: *A Screenshot from a personality assesment conducted on the virtual 3D enviroment*

the questions are answered by players, the game skips to the next scene - Game Over Scene- to examine his or her personality.

The empirical part of the study took place in METU Technopolis between 16.12.2015 to 21.12.2015. Participants of this study were the software practitioners who worked in different companies that resided in METU Technopolis area.

4 Results and Analysis

This section illustrates statistical evidence based on the collected data for paper-based test and the test conducted in 3D interactive environment. Ultimately, ther goal is the show empirical evidence for showing the difference between two assessments. This section presents frequencies of detected personality from the participants.

There were 21 people who participate to this study, 16 (76.2%) of them were man, and 5 (23.6%) of them were woman. 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.

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. 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. 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.

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. 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 was 60 whereas lowest score was 12 and the mid score was 36.

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

In this context, the hypothesis of this research is;

- H_0: The experience that the participants receive from both of the assessment methods has no difference.
- H_1: 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 value is 7.131. The calculation of paired samples t-test were performed using a computer, and the significance level were calculated as zero (p= .000), i.e. the probability was so small that computer rounds the number into zero. In situations such as this, the probability value shall be written as $p < .001$.

The calculated t-test indicates that the null hypothesis (H_0) is rejected and according to 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;

$$\text{Estimated d} = \frac{\text{sample mean difference}}{\text{sample standard deviation}} = \frac{M_D}{s} \tag{1}$$

M_D is calculated as difference between "second survey score" and "first survey score" over sample size (n), which was calculated as 9.85 and standard deviation (s) calculated as 6.335 and Cohen's d was 1.55[5]. Since it is calculated that the d equals 1.55 the effect size of this study was large.

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

$$M_D = \frac{\text{difference}}{\text{sample size}} = \frac{\sum D}{n} \tag{2}$$

[5] Cohen's d any value greater than 0.80 is considered to be large effect.

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. Parameter for Wilcoxon test were the same as the paired sample t-test above (level of significance ($\alpha = .05$). 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 $p < .0001$.

Validation Interviews

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

- What do you think about the generic functionality of the software product?
- What kind of improvements would you suggest?
- Do you think there are advantages of interactive assessment environment over paper-based assessment?

For the first question, participants of validation interviews stated that the software product helped to reveal the personalities of software practitioners such an approach might reduce the problems that "human factor" causes. In addition, the software product was useful to software team forming and it helped to improve the software development processes when the personalities of practitioners were in consideration. In fact, one of the participants of the interviews stated that

> ***Interview quotation:****"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, he also mentioned that some bugs 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 one participant also 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 suggested that

Interview quotation: *"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 were considered as an advantage by majority of the interviewees.

5 Conclusion and Future Work

The main purpose of this research was to propose a 3D interactive approach to reveal personality types 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 was significant difference between the results of first survey and the second. This indicated that the proposed method worked as it was intended. Furthermore, similar to the results of the analysis, the validation interviews also indicated that the interactive personality assessment environment was helpful to improve the software development processes for revealing personalities of software practitioners. Although, this marks the end of this research there were still various improvements should have been done as a future work.

The proposed method, in its currents 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 showed that interactive assessment should include more entertaining dialogues that all game-like approaches should have. Future releases will have features such as; (i) 3D environments with more office like interactivity, (ii) theme based animations, graphics and improved sound effects, (iii) rather than asking directly, the questions can be embedded into a story.

In addition, the time required to complete the interactive assessment needs to adjusted well to avoid being repetitive and boring according to validation interviews. The current state of the interactive assessment environment runs only desktop computers. Future mobile releases 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 the 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 voxelization[6], and occlusion culling[7] that may require to be used in the interactive assessment environment.
– Lastly, a possible addition of new characters, environments, animations 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) were noted for future improvements. Virtual reality has become a huge phenomenon in recent years and poses great potential for scientific research with its interactive and immersive features. Therefore, further research in this field would be of great help for improving the proposed approach.

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

[7] 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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