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A usability assessment for a career planning educational video game

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ABSTRACT

Wang, Jiaqi. M.S., Purdue University, August 2016. A Usability Assessment For A Career Planning Educational Video Game. Major Professor: David Whittinghill.

This study focused on the design, implementation and usability assessment of an educational 2D iPad job matching game The Place You'll Go (TPYG), which meant for matching student skill sets with career profiles. The development of the game is conducted in collaboration with Purdue University's Krannert School of Management and Polytech Institute. A total of 7 subjects, as high school teachers, participated in the usability study. TPYG as one possible solution for job matching data visualization, did not provide players with a good experience. However, conclusions and findings can be used in similar education game development. Based on survey and analysis, new feasible and scientific plans were made for future development.

CHAPTER 1. INTRODUCTION

This chapter describes the background of this research study. In this chapter, the

definition of research question and statement of the problem, research scope, significance

and definitions are discussed. This chapter also presents the assumptions, limitations and

delimitations of the study.

1.1   Statement of the Problem

The Krannert School of Management of Purdue University provided data for

matching jobs profiles with required sill sets. The data revealed the relationship between

majors and potential jobs. By using the data, users are able to tell their future career plan

more clearly. However, the biggest issue of the data is its size. There are 116 jobs

involved in study, the scores among each of them should be defined. So, the total

dimension of the table that shows the whole data is 116 by 116. Besides the main giant

table, there is another table that show the characteristic data of every job. Because each

job is described in 8 different aspects, beside its name and category, the table used to

contain all the data should be 10 by 116. The value of the 8 aspects are called

characteristics.

It is hard for most learners to get familiar with such a huge size of data. There is

evidence showing that knowledge or information is easier to perceive for learners, when

it conveyed through a game (Moreno 2008). One of the better ways to explain the data and make people learn it effectively can be integrating the data into a finely designed video game. Based on the fact that it is widely agreed that games are playing as a positive role in education, gamification is a possible solution for data visualization.

The result from this research is helpful to game developers who are looking for a way that illustrates data efficiently. The result can also contribute to keeping the maximum entertainment or enjoyment of the game without any concession to educational purpose.

1.2 Scope

Due to the its portability and the large screen, iPad was the platform that the study focused on. There are built-in sensors such as the accelerometer that can be used for future development. The first target users of the game are iOS users. When doing usability test, the game was installed like a normal app on iPads directly from Xcode. Due to platform limitation, there was no guarantee that the research result is applicable on platforms other than the iOS. However, results may also be applicable to other generic games.

1.3 Significance

Serious game development is a branch of data simulation. By providing a suitable way of exploring the two big tables from Krannert School, the game will help students get a better sense of career data. The better they have learned about the data, making them more likely to pursue the right career paths when graduate. Additionally, for people who have just finished their high school, the data will be an ideal resource when deciding

their major. But no student will be willing to use the 116 rows of data and perform this exercise.

By implementing a fun game for the whole data, users are able to get a chance to learn the jobs' information by playing the game. And a usability test on the app is a guide for upcoming educational game developers.

1.4   Definition

Aesthetic elements: Game aesthetics concerns the representations used in games and the
   functional aspects of those representations, and the relationship between the
   two. (Chris, 2012) Game art design, a subset of game development, is a process of
   creating 2D and 3D game art for a video game. A game artist is a visual artist who
   creates video game art, such as concept art, item sprites, character models,
   etc.(Bates, 2004; Bathke, 2003; Chandler, 2009; Moore and Novak, 2010)

Game Mechanics: Game mechanics are methods invoked by agents, designed for
   interaction with the game state. (Sicart 2008)

Serious Game: A serious game or applied game is a game designed for a primary purpose
   other than pure entertainment. (Djaouti, Alvarez, and Jessel, 2011) The "serious"
   adjective is generally prepended to refer to products used by industries like defense,
   education, scientific exploration, health care, emergency management, city
   planning, engineering, and politics.

TPYG: The short name for The Place You'll Go, which is the name of the game that we
   have developed. The game is designed for iOS platform, especially on iPad.

1.5 Research Question

Does TPYG, as an educational game, provides a good user experience when user interacts with the product for the first time?

1.6 Assumptions

The assumptions inherent to various human and environment factors includes:

1. The participants are supposed to answer the questionnaires without any misunderstanding. To avoid misunderstanding, each participant will be given a basic description of the statement list. They will be told to ask me for clarification, if they encounter any difficulty or confusion in reading or understanding the test.

2. Endeavor of participants is required as well, which requires them to be patient and pay full attention through the test. The test includes four steps: pretest, game playing, posttest and survey.

3. The third assumption is that the answers provided by participants are reliable. Each participant should obey the discipline that they are going to present their opinions with honesty.

4. The person who finally finishes the survey should be exactly the person who got the invitation email. Each test is assumed to be finished by one person individually.

5. The environment of the participants who are taking the test should not be stressful. Adequate amount of time should be available for each participant to finish the test.

1.7   Limitations

The research limitation is confined to particular situations including:

1. Only the voice, finger movement, transcript of each participant was recorded.

2. The participants are teachers from high schools around Lafayette area, therefore the result may only applicable among these particular group of people or from similar situations.

3. The survey only focus on the people who had the experience of using the equipment for the test. For example, the participants must know how to use iPad where the app runs on, and be able to access the internet easily.

1.8   Delimitations

The delimitation is confined to particular situations includes:

1. There could be other unseen factors influencing the result.

2. Those who violate any rule in usability test are not in consideration.

1.9   Summary

This chapter discussed the background of study, that the research is based on an educational game collaborated with Krannert School, called TPYG. Development of the game is done before implementing the usability test. Then the statement of problem, research scope and significance of doing the study are introduced. The research was aimed to evaluate the usability of the game, which is helpful for designing an educational game showing data that not friendly for reading. To minimize misunderstanding, definitions of terms in the research such as TPYG were discussed as well. Besides, to confine the situation that the research result may apply to, assumptions, limitations and delimitations were preset.

CHAPTER 2. REVIEW OF LITERATURE

This chapter includes the review current studies related to my thesis. Two aspects of the literature are discussed, which are educational games and gameplay evaluation. Through this chapter, related works and gaps are defined.

2.1   Educational Games

This section will focus on educational games. The literature scope includes general game design, difference between educational games and edutainment games. Then, the literatures of serious game design are discussed. Finally, multi-platform educational games will be studied, because of their popularity in recent years.

2.1.1   General Game Design

Game design studies have proposed several models of game development, such as persona based development, educational aim based development, aesthetic based development, etc. Among the researchers, Charles, Kerr and McNeill (2005) provided an approach to player-centered game design. The approach was mainly focused on three areas, which are understanding players, modelling players, and adaptive game technology. They believe when designing a game, the designer should always have a specific type of gamer in mind.

2.1.2   Edutainment vs. Educational Games

Denis and Jouvelot (2005) argued that "The main characteristic that differentiates edutainment and video games is interactivity, because, the former being grounded on didactical and linear progressions, no place is left to wandering and alternatives" (p. 464). Edutainment games lack variety in gameplay. Compared to edutainment games, educational video games require more sense of game playing, like strategizing, hypothesis testing, or problem-solving, usually with higher order thinking rather than rote memorization or simple comprehension. (Dondlinger, 2007)

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2.1.3   Serious Game Design

The use of educational games in learning environments is an increasingly relevant trend. Amory and Seagram (2004) studied the relationship between the Persona Outlining Model (POM) and the Game Achievement Model (GAM). Their study result revealed that GAM is an efficient, well conceptualized and supportive model that story writers and developers can easily take advantage of and for complex learning environments. Moreno-Ger, Burgos, Martínez-Ortiz, Sierra, and Fernández-Manjón (2008) provided a general rule of online educational game design containing three stages. Firstly, developers should

choose an appropriate genre, then add assessment and adaption to the design, and finally integrate with an online environment. Besides this research, Song, and Zhang (2008) proposed the EFM model for educational game design through describing the internal connection of motivation, flow, effective learning environment and educational game. Two years later, Song and Zhang (2011) applied the model to educational game design and pointed out that how their model reflects Norman's seven effective learning conditions, which are condense interaction and feedback, clear goals and procedure, incentive mechanism, continuously challengeable, providing sense of participation, providing assistant tools, and no interaption. Annetta (2010) provided six elements of educational game design, which were derived from several studies on game design and development from Grade 5 through graduate school. These nested elements are identity, immersion, interactivity, increasing complexity, informed teaching and instructional. Tang, and Hanneghan (2011) introduced a new game content model that can aid game designers document specification of game design. Their game content model consists of ten components, which are Game Structure, Game Presentation, Game Simulation, Game Rule, Game Scenario, Game Event, Game Objective, Game Objects, Game Player and Game Theme.

However, Dickey (2006) analyzed "how narrative in adventure games supports problem solving, and how methods, devices, and techniques that support narrative in adventure games might inform instructional designers and educators" (p. 260). The paper has an important discovery that says "the types of narrative structures that serve to entertain likely will not meet all educational goals" (p. 261).

2.1.4 Multi-platform educational game

Miloš (2009) proposed with their method of implementing educational games in mobile platform and different devices. Their idea was based on extracting knowledge, game rules and scenarios outside the program thus enabling reusability. Furió, González-Gancedo, Juan, Seguí, and Rando (2013) presented an initial study to determine the subject preferences for educational computer games for children. They developed an iPhone game illustrating the same knowledge as traditional games. In the result, no significant difference was found between the learning outcome of two groups of students using the iPhone game and the traditional game. However, an overwhelming percentage of participants expressed their preference to iPhone game and showed their intention to play the iPhone based game again. This study revealed that mobile device may have better attraction to adolescent players/students.

2.2 Game Experience Evaluation

It's worthwhile to study the measurement and evaluation method in educational software design and implementation. This chapter discusses the measurement history on multiple aspects of educational games. The aim was focused on educational outcome evaluation, affective response and player's behaviors.

2.2.1 Affective response

It is widely accepted that games are designed for entertainment and players' enjoyment. Developers always try various method to improve entertainment values. Yannakakis and Hallam (2009) for example, came up with a methodology, which is an adaptive mechanism that adjusts controllable game parameters in real time. The main

idea for the mechanism was applying machine learning technology in game. However, it was hard to acquire proper and "clean" user data.

There are multiple aspects that affect player performance: difficulty, immersion, story, art work, etc. Klimmt, Blake, Hefner, Vorderer and Roth (2009) conducted a study that investigated the impact of game difficulty and player performance on game enjoyment. Results suggested players to "(1) change their view on their own performance with its implications for enjoyment with increasing game experience and (2) to switch strategically between different sources of fun, thus maintaining a (somewhat) positive experience even when performance-based enjoyment is low" (p. 1). Besides, results indicated that in general, players evaluate worse for their performance if they were playing in an environment with harder difficulty. And the easier the game is, which means the higher number of success experience (such as killing number), the higher game enjoyment the players can get. Similar to this, the less they fail, the higher enjoyment they feel. On the other hand, player performance and enjoyment may influence each other. Shim, Srivastava and Hsu (2011) did an exploratory study of player performance, motivation, and enjoyment in Massively Multiplayer Online Games (MMOs). They collected data from the games' operational data, game logs for instance, to estimate the difficulty of tasks and player performance. And then a large-scale survey was made to evaluate the enjoyment of the players. Their findings indicated that the correlations do not fully conform to the flow theory and additionally suggest that the knowledge of player motivations is critical in accurately predicting player enjoyment. Their result showed us two things. First, they discovered that there's no evidence showing that the performance of players predicts the intention of quitting. Instead, their motivations are

more significant in predicting the results. Second, we can see that players' flow state can be a predictor for their fun level, which means the higher they performed in game the higher enjoyment they got.

2.2.2 Measurement of players' behavior

There are several different models of player enjoyment in computer games, ranging from the work of Malone (1981) on intrinsic qualitative factors for engaging game play and Sweetser, and Wyeth, (2005) model (WeHagelbäck & Johansson, 2009). WeHagelbäck and Johansson (2009) made a study to answer the question "Do players find it more enjoyable to win, than to play even matches?" Their measurement was letting the players express their experience in terms of a number of adjectives of six different clusters relating to the strength, the variation and the enjoyment and their opposites (weakness, predictability, and boredom). Then they analyzed the players' opinions about the enjoyment to their opinions about the strength and the variation of the computer opponent. Fang, Chan, Brzezinski and Nair (2010) reported on the development of an instrument designed to measure the enjoyment of computer game play. They developed a survey based on on Nabi and Krcmar's (2004) tripartite model of media enjoyment, to measure computer game players' affective, behavioral, and cognitive reactions. Furthermore, Ijsselsteijn, Hoogen, , Kort, Lindley, Mathiak, Poels, Ravaja, Turpeinen and Vorderer (2008) developed and validated the Game Experience Questionnaire (GEQ), which reliably distinguishes between seven different dimensions of player experience: Sensory and Imaginative Immersion, Tension, Competence, Flow, Negative Affect, Positive Affect, and Challenge.

In educational game, Fu, Su, and Yu (2009) developed a more rigorous scale that assesses user enjoyment of e-learning games based on Sweetser and Wyeth's (2005) framework. They designed the scale development in three stages: (1) The validity evaluation of the scale items was valuated. (2) Test consists of a pre-test, a reliability test, and a validity test. (3) Formal testing of the scale's reliability and validity.

2.2.3   Usability Test

Because TPYG is built based on tasks, the method that we use to measure the players' performance should be suitable and as objective as possible. Fortunately, Lin's (2013) research on the relationship between usability and technology acceptance model discovered that usability attributes seem to be more objective and consistent while measuring a specific task performance.

There are existing ways of evaluating a system. Most of the usability tests are conducted on survey-based tests where subjects are required to finish the survey after interacting with the target system. Brooke (1996) provided a quick and dirty measurement that allows researcher to run usability tests in a low cost way. Brooke's method can be used universally, even when doing usability tests on industrial systems evaluation. Albertazzi, Okimoto, & Ferreira (2012) also used usability tests when evaluating their Augmented Reality (AR) project to evaluate if augmented reality helps the process of learning how to use a new product. A study conducted by He (2014) in Purdue University used the method of a think aloud usability test on a serious game, MAEGUS. The usability test successfully helped the researchers find out how students use a series of information visualizations to operate a multi-variate game-based simulation and the associated usability issues.

2.3   Summary

Expressing narrative knowledge through video games is a trend of education. This chapter has provided a summary of related review of literature in terms of different models realated the topic. First, in aspect of game design, plenty of studies have proposed several models of game development. Based on the difference between edutainment game and educational game, models were built for serious game development on multiple devices. Second, in terms of measurement and evaluation work, models of evaluating educational outcomes are deeply studied, however there are limitations on situations when each is applicable. Third, the method for usability test is widely used in systems.

Based on the review of the literature, there is a trend of making a gamified app for educational purpose. TPYG, a task-based game full of interaction is made according educational principles. For this game, a trustworthy and robust method to evaluate player's enjoyment was used, which was Brooke's (1996) SUS survey format.

CHAPTER 3. METHODOLOGY

The purpose of this study was to find the relationship between aesthetic elements and outcome of educational game, independent of game mechanics. The outcome of educational games is affected by multiple factors. Two main factors are aesthetic elements and mechanics. In order to reach the research task, it is necessary to design a survey with enough participants and compare two solutions of the same game. The survey was based on an educational game that has been designed for data visualization and teaching purpose. The game is temporarily named *TPYG*, short for *The Place You'll Go*, which is currently under development.

3.1   Research Approach and Hypothesis

The methods developed in this study is designed to answer the research question: Does TPYG, as an educational game, provides a good user experience when user interacts with the product for the first time? According to the research question, independent variables and dependent variables are defined as:

The independent variable in usability test was interactions when user learns how to play the game, while the dependent variable was the usability, which was subdivided into 8 metrics according to Brooke's (1996) SUS method.

This was a quantitative study with qualitative elements. Further details about data sampling and data analysis are discussed in the following two sections. The result of

quantitative data analysis was used to test the hypothesis derived from the research questions:

H0: There is no significant evidence that proves user playing the game TPYG has a positive gaming experience as he or she interacts with the game for the first time.

H1: User playing the game TPYG has a positive gaming experience as he or she interacts with the game for the first time.

There were two parts of the research, implementing the software and doing a usability test for it. When doing usability test, subjects were provided with surveys with questions that are all about the playing experience in game.

3.2   Game Development

In this section, game design of TPYG is discussed, which can be subdivided into four aspects: background and educational goal, data structure, game structure and the first mini game using navigation mechanism.

3.2.1   Background and Educational Goal

Krannert School of Management is conducting a program in Indiana area to help people understand the potential career paths of different majors or jobs. Data evaluating how a person perfectly fits a particular job was developed by Krannert School. By learning from the data, people are able to pick their future careers or major in an easier way.

However, the size of data is too big for most people, even those who are highly educated. Thus, a better way to visualize the data is need. Based on the situation, a team

for visualizing the original data was built up by people from Polytechnic Institute of Purdue. There are two groups of the team, one of which was engaged to develop a web based visualization tool to reveal the data, while the other one's task was to implement the educational game. The author and researchers of the present paper are from the game team. The research goal of the study is part of a bigger goal of the whole team.

3.2.2   Data Structure

As mentioned in the last paragraph, the size of data is too large and unfriendly to read and learn.

There were 116 jobs under the study of Krannert School. Each job has an attribute describing the category it is in. They quantified 8 characteristics for each of the jobs, which are verbal skill, quantitative skill, reasoning skill, salary preference, task flexibility preference, female friendly preference, Midwest preference and family friendly preference. Thus the first part of the data is a table with 10 (characteristics plus category and name) by 116 dimension. Figure 3.2.2 are radar charts that represents examples of two different jobs with their characteristics. The characteristics are represented in a scale from 0 to 1, which represent the importance weights: how much does the client care about this characteristic? The scores for each characteristic (task flexibility, female friendly, mid-west, family friendly, verbal skill, quantitative skill, reasoning skill, salary) are the importance weight that each client places on that characteristic. Some clients care a lot about earning a high salary (salary score close to 1) while others don't care about the money (salary score close to 0). Those clients who don't care about money do care about other characteristics. For example, a job with a verbal skill with 0.8 score means that that

job requires a pretty high level of verbal skill. And, 0.2 on salary means that salary is not a key point when usually an applicant applies for that job.
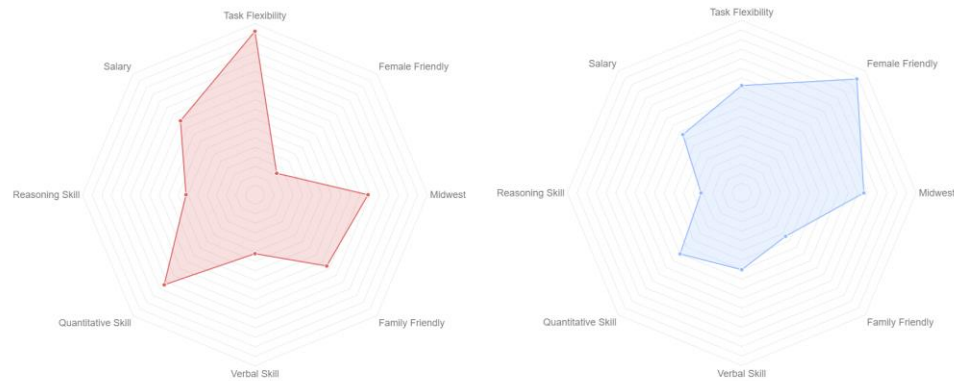

Figure 3.2.2 Characteristics

The second part of the data is matching information. Each job has a matching score with all other 115 jobs and itself. To represent the data, a 116 by 116 table was developed. The matching procedure is that: pick one job as the first job, find another job that wants to be matched to and, finally, a score of matching can be shown. For example, the user may wonder as a computer programmer, how match would it be if I choose to be an aerospace engineer. The result might be 60%, which means it's 60% likely that a computer programmer is compatible with the job working as an aerospace engineer. However, there are two things that must be noticed. First, matching A to B is different from matching B to A. For example, most food managers might be 100% compatible for any waiter job, but it is unlikely to be easy for a waiter to work as a food manager. Second, as a preset, when the same job matches itself, the score is 100%.

In summary, the data include two tables, one is 10 by 116 and the other one is 116 by 116. The size is too big for reading and even causes some "not responding" errors

when opened it using Excel on Windows. The goal of the game is to solve the problem by making the learning procedure more intuitive, interesting and enjoyable.

3.2.3 Game Structure

My participance to the project started from May 2015. The team kept using SCRUM method during summer semesters and had regular meetings every two days during normal semesters. Unity was the game engine we used to implement the game. For scripting language, we chose C#. The target platform was iPad with screen resolution of 1024 by 768. Hundreds of testing were made on iPad and Windows.

In order to separate the work content, the whole game was divided into two parts: the meta game and the mini games. Meta game is where universal data is stored and displayed, such like unlocked counselors and mini games. Mini games are where players actually learn things, which are independent games that have different design and mechanism.

In meta game, we introduce 5 counsellors and mini game map. To give the user a better idea about the game, there is also a tutorial level. The 5 counsellors were designed as five different themes. Only one counsellor can be chosen at the beginning. Player unlocks better counsellors by collecting clients card, which are related to the helped clients. We assume that the more diverse the game is; the better experience the game provides. Figure 3.2.3 (a) shows the pipeline of unlocking counsellors and themes related to each counsellor.

Figure 3.2.3 (a) Meta game pipeline

The mini game map is one scene with all the access to each mini games. The tutorial level is designed to explain how the meta game works and what the players are supposed to do during playing. The game flow in meta game is as described below.

1. After tapping and opening the app, a welcome screen shows, and player can tap anywhere on the screen to go on.

2. If it was the first time the game is opened after downloading, a tutorial level is the next thing the player needs to go through.

3. After tutorial level, player is in a "Profile" screen, a place which allows player to choose their favorite counsellor (if unlocked).

4. When the favorite counsellor is decided, player goes to the mini game map to pick the mini game that he or she is willing to try. The buttons of each mini game are on the map, looking like a part of the map blinking.

5. After tapping on a button, player starts a mini game.

Mini games are the main part of the app, since mini games are the only places where users are able to learn something. In another word, mini games are designed for

educational purposes, while the meta game is for more entertainment. There are three ideas and designs of mini games:

1. Navigation Game. Before playing the mini game, five clients were enrolled and player plays as one of the five counsellors. Play should have time to learn about each client after enrollment. Player's goal is to help them get the best job they can. During the game, job offers comes from the right side to the left, player is asked to navigate them to the right client using tools. There are tools with different functions, including detouring, repulsing, destroying, attracting and so on. Using these tools consumes energy, which requires the player to keep collecting energies while gameplay.

2. Maze Game. The client is at the center of the screen at the beginning of the game, meanwhile at each corner of the screen lays one job offer. The map is full of obstacles and functional objects. The goal is to lead the client to the right job among the four. To move the client, player tilts the device so that the client would "slide" toward that direction. The information of client is learned by the player while playing when client talks continuously.

3. Card Game. This is a multiplayer game while player has the option to play with artificial intelligence. After each player gets his or her client, a card with a job's information is displayed in each round. To win the game, player need to compare the information on the card and the client, and decide whether the job offer should be accepted or not. If the card is taken by one player, it is no longer be available for the other one to pick. If a bad job is taken, the player loses point.

Totally, there are four senses in meta game, whose name are MetaWelcome, MetaTutorial, MetaProfile, MetaMinigameMap. The namespace SceneManager was used for jumping between scenes for iOS devices. For the mini game – Navigation, there are two scenes created for it: NavTutorial and Nav.

Besides the scenes, data storage is one important step in game design and development. All clients have three statuses: idle, thinking and talking. Each client is formed with three body parts, which are head, torso and legs. Based on that, there are 9 pictures for each client. In total, the number for clients are 24 by 9. To store the data scientifically for future use, we created a class to store related data. Figure 3.2.3 (b) shows the way storing date in Unity editor.
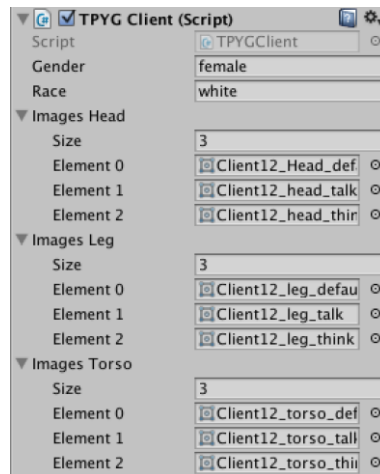

Figure 3.2.3 (b) Data Storing

There are several main potential issues that were not solved before usability test. These issues include bugs and bad gaming experience issues:

1. When recruiting clients, the game has a low chance to freeze when a recruited client turns into a card. This doesn't happen all the time, but happens sometimes. The cause of this bug has not been found yet.

2. The refresh rate is not high enough to simulate objects' movement. For example, text like "Adventure Begin" should fly from left to right with the speed being fast at the beginning, slowing down gradually till the middle and then speeding up to the right. Since the refresh rate is not high enough, the text's movement looks like jumping, when its speed is relatively fast.

3.2.4 Navigation - The First Mini Game

Navigation Game is the first one that was fully implemented, which was the only mini game for test in this study. Before we actually introduce the game play part, some terms need to be defined first:

1. Clients: In order to make the game with the highest diversity, clients are designed and drawn in different races and genders. We designed clients in four major races, which are White, Black, Asian and Latin. For each race, we designed four characters, which are two males and two females. In total, there are 16 different looking clients. By doing such work, the game can always be fresh and exciting.

2. Counsellors: Counsellors are characters that play an important role all through the whole game. Players have the option to pick a counsellor and play their role. There are 5 counsellors, named as Farley, Lucie, the Coach, the TED woman and the Sage. The counsellor artwork is interesting and appealing. In a mini game, each counsellor has his or her own theme. The appearance of background, tool effects, energy icons are all different. The name for each counsellor's backgrounds are Farley's Boat, Lucie's playground, the Coach's Football Field, the TED woman's Lecture Hall and the Sage's Wonderland.

3. Tools: Tools are used to navigate job offers. To detour a job or jobs, player needs to plant the tools in the right place. Currently, tools we created are Magnet, Repulsor, Mine, Tornado and Block. Magnet is used to attract all the jobs on screen towards the place where the magnet is. Repulsor should be used when player is hesitating on a job by pushing back a job offer back a little bit, so that it attains more time for player to think. When a job offer doesn't suit for any client, player might want to destroy the job offer using a mine. To clear a lane and detour all the job offers on it to the lane next to it, tornado should be the best choice. If player still needs time to think on a job offer, block works best for stopping it for a while. When player wants to use a tool, they simply drag the tool from the bottom of the screen to where needed.

4. Jobs offers: As mentioned before, there are 116 different sorts of jobs, it could be a tedious work if the artist in the team drew one image for each of them. Even if the work was done, it doesn't help much for the player's understanding of the jobs. However, there are only 16 categories for all 116 jobs. So, there is one image for all the jobs under one category. This will also help the user understand each job's category knowledge.

5. Energy: Energy value is listed on the left corner on the top of the screen. Player is not allowed to plant a tool on the field unless he or she has enough energy to do so. Different tools consume different energy to plant. For example, it consumes 7 energies to plant magnet, which means that the player is not able to finish the planting action and every time a magnet is placed successfully on the field, 7 energies are deducted from the total energy. Energy can be collected by

tapping or swiping on falling energy stars through the game play and are easy to notice.

6. Other mechanism: Tap and hold can be used on clients and jobs to view the detailed information. Pausing and restart are UI functions that are designed for the situation when player is not able to pass the level. Shovel is provided to players so that they are able to remove any planted tools on the field that they no longer need. Grid map is designed for the map of the field and can help organizing tools and jobs in their positions in a clean way.

Terms are discussed above for the better understanding of game content. Figure 3.2.4 shows the game contents of the mini game.
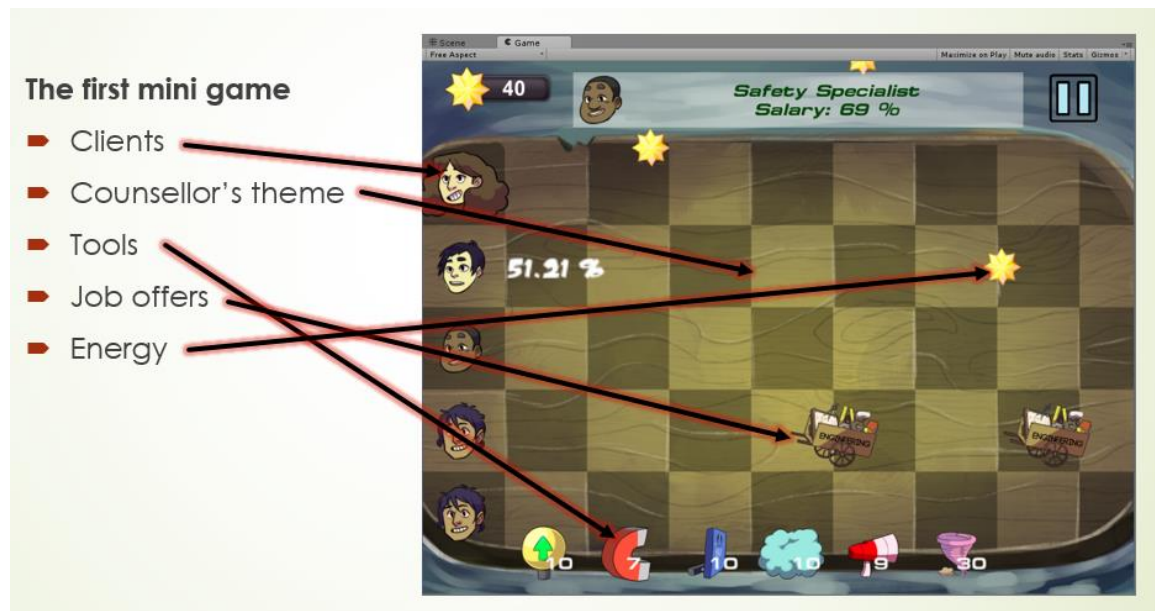

Figure 3.2.4 Mini game components

The detailed game flow is as described as follows:

1. Enrollment of clients. After choosing the counsellor, clients come to the player one by one. To get one client into the team, player interacts with the client by

swiping according to a set of direction symbols, like "up down right". By doing this, the player gets to know the characteristics of each client.

2. Learn about the clients. After swiping successfully, the client turns into a card with all the information about him or her on it. The 8 characteristics and their values are represented as a progress bar, so that the client's info can be learned by seeing the card.

3. Start and play game. There are five lanes in the mini game. Job offers coming from the right side of the screen are designed according to different concept of each jobs. They are generated one by one randomly at the end of one of the lanes. Once a job is generated, it moves slowly towards left.

4. Navigate the job offers using tools. Since people accept any job offer that comes to them, the player needs to guide the job to the client who needs it the most. In other words, a job offer should go to the client, whose characteristics matches the best with the job requirements. There are multiple tools like, magnet, blocker and mine. Tools have different functions when using them. Players take advantage of each tool's ability to lead jobs towards the client who want it the most. When a job reaches a client, a matching score will be shown at that moment, so that player will know how well he or she has done in matching the task.

5. Player win the game by helping all the clients with a particular matching score (varies from counsellors). There are preset goals for each level. For example, to win the game with the Coach (one of the counsellors), the football field player needs to get at least 60% match for every client. When all the five clients are

helped by the player, five cards are collected for the record of the player's journal. On the card, there is information about characteristics and the image of the client. Cards are used in the future for viewing helped clients. Cards are also the key to unlocking new and higher-level counsellors.

3.3   Usability Test

To evaluate the user experience of TPYG, a usability test is conducted. Seven participants are collected for the usability test, who are female teachers from local high schools. Their ages vary from 20-29 to 40 or older. Materials need to be prepared before the test and the procedure for conducting the test are discussed in this section.

3.3.1   Testing Materials

Before the usability testing day, following materials need to be prepared:

1. Survey: The survey that we used for the test is Brooke's (1996) SUS method, a universal method when doing usability test on industrial systems evaluation.

2. Room: A lit conference room on the second floor of Burton D Morgan Center for Entrepreneurship (MRGN)

3. iPads: Because the subjects are divided into two groups, of 3 and 4, four iPads with the game already installed is required.

4. Video recorders: Video recorders are used to track subjects' finger movement and voice. For the same reason of the requirement of iPad, 4 recorders and 4 tripods were needed for the test.

5. IRB approved consent form (see Appendix A)

3.3.2   Procedure

There are two main steps for one participant to finish the testing procedure, which are preparation and running the test. Before any manipulation being executed, this research study underwent an Institutional Review Board (IRB) review and approval.

The usability test on subjects is started when all the following conditions are ready:

1. All participants are seated comfortably with consent form on hand.

2. All iPads in front of participants are fully unlocked on the home screen where the game icon is located.

3. All cameras are on, looking towards its target iPad screen. The SD card in each camera must have at least 64 GB for HD video storage.

The test run through the following procedure after all preparation works are done with no problem:

1. The facilitator explains the task of playing the game and asks the participants to "think aloud", which means that the players are required to always speak out their feeling while playing. Then consent forms were collected.

2. Camera recording: Inspired by Tonbuloğlu, (2013) using video recording for a usability test on an educational software to study on gender effects, this research decided to use collect information of players on game aspect by recording their finger movements while playing on iPad. Because TPYG is a game that is designed with a large amount of finger interaction gestures, capturing players' behavior like tapping, swiping, dragging and holding will contribute a lot on the study. Using the data of the record of finger movement, researchers should be able to learn the deeper side of how the player is clear

with the game's mechanism. If the player understands everything as developers expect to, what are the first things that they are likely to do after getting a notification or an alert in the game and many more such questions.

3. Participant tap the game to open and actually play the game. Though they are asked to keep talking, there will always be cases when they stop talking. At that moment, the facilitator would go to the participant and ask her how does she agree with the experiencing statements related to the information on the screen.

4. The playing session lasts 10-20 minutes, after which each participant must finish the SUS usability test survey. (See Appendix B) Before the survey, cameras stop recording. The survey has two parts. In the first part, participant's information about age, gender, highest academic degree and employment status were collected. The second part is formed with 11 usability-based interval scale questions, asking about agreement strength. The answers range from strongly disagree to strongly agree as two extremes in 5 scales, with disagree, neutral and agree in between.

5. The whole test for one participant is over when her consent form and survey is handed in.

3.4   Summary

This chapter provides an overview of the component parts of the proposed study. Variables and hypothesis were defined in section 3.1. In the following section, content of game development was introduced in four aspects, which are developing background, data structure, game structure and the first mini game Navigation. Next, the procedure of usability test is described in the following section.

CHAPTER 4. RESULTS

The chapter represents the technical reveals and findings of the usability test. Data listed in this chapter are used for further research to answer the original research question: Does TPYG, as an educational game, provides a good user experience when user interacts with the product for the first time?

4.1   Participants

Participants are from local high schools. All of them are employed female teachers. According to the forms they submitted, Figure 4.1 shows the proportion of subjects' age and education level. All 7 participants answered all the 11 statements on survey form. However, one of the participants chose "Strongly Disagree" for all statements. We don't treat that form as a valid usability feedback. When doing result analysis, her answer was discarded, because there's a high possibility that she just finished the form without any thinking and we don't want to take that risk in the study.
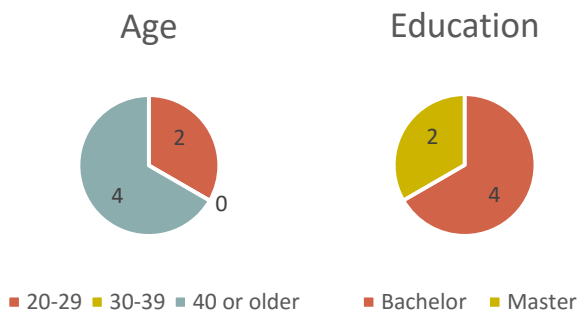
Figure 4.1 Participants

4.2   Report

Figure 4.2 shows the result of all the 6 participants' answer. For each statement, a pie chart is made to represent the answer proportion. In the charts below, different color represents different opinion from participants:

Red – Strongly Disagree (Agree score = 1)

Yellow – Disagree (Agree score = 2)

Blue – Neutral (Agree score = 3)

Grey – Agree (Agree score = 4)

Green – Strongly Agree (Agree score = 5)
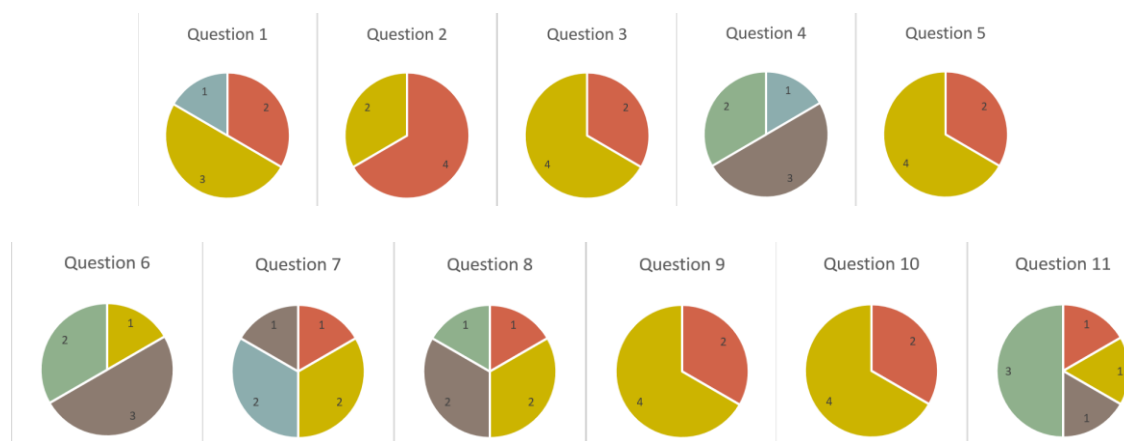
Figure 4.2 Pie charts report

After the survey, participants are asked to write down any comments at the bottom of the survey. Most of the suggestions given by them is making the instruction clearer. The tutorial level is the level that they dislike the most. There are three major problems of the tutorial levels:

1. It didn't help them understand how to play the game. Player has no idea what she was expected to do even after going through the tutorial level.

2. The tutorial level took too much time, which could make player get bored and tired.

3. There was no significant alert or pop-up window that tells player that she was in a tutorial level instead of the actual game.

4.3   Analysis & Conclusion

The raw data from the usability test was analyzed. This section starts with analyzing the result through each statement answer proportion by combining data with participants' background. There are also comments written down on the survey, which helped the usability procedure. The third resource of raw data is the videos and transcript for each participant, from which we get information about their user experience and finger behaviors. To protect the participants' confidentiality, we use numbers for each of them.

4.3.1   Statements

Statement 1 description: I found the game fun, without repetitive or boring tasks. Half of the participants' choices are "Disagree", while two of them chose "Strongly Disagree" and only one stood on a neutral position. For agree score, $\mu = 1.83$ and $\sigma = 0.75$. According to this result, we can come up with the conclusion that the game is not as fun as the participants expected. There are some reasons that might cause this phenomenon. Firstly, there are two tutorial levels that require the player to go through before they actually start playing the main mini game. This reduced the players' enthusiasm and curiosity. Secondly, there is not enough instruction telling them the reason why they are supposed to use gestures like swiping.

Statement 2 description: The purpose of the game is clear. The answers from participants on this statement was different from our expectation, because 4 of them strongly disagreed with the statement and the rest 2 chose "Disagree". For agree score, μ = 1.33 and σ = 0.52. There is enough evidence from this result representing that the method we used to clarify the goal of the game was totally a failure. The tedious tutorial level and long paragraphs of text are to be blamed.

Statement 3 description: I think that I would like to play this game frequently. The result on this one is a little bit better than that of statement 2. Most of the teachers chose "Disagree", while 2 of them checked "Strongly Disagree". For agree score, μ = 1.66 and σ = 0.52. It can be interpreted that they were not willing to spend their time on the game frequently.

Statement 4 description: I found the game unnecessarily complex. One participant kept a neutral position, 3 agreed with the statement and 2 strongly agree with it. For agree score, μ = 4.33 and σ = 0.82. The conclusion that we were able to draw from this part is that the game's complex design of the game made players feel that it was too hard to understand and get control of the game. However, if players think a game too hard to play, it can always be a problem.

Statement 5 description: I thought the game was easy to use. The opinions of the participants on this statement was exactly the same as question 3, which is that 4 chose disagree and 2 strongly disagreed. For agree score, μ = 1.67 and σ = 0.52. Actually, the result of statement 4 is an explanation for this result. No one could feel anything easy to use if it was designed too complicated.

Statement 6 description: I think that I would need the support of another person to be able to play this game. Half of the participants agreed with this statement. 2 of them didn't show their opinion and only one thought she could finish the game on her own. For agree score, $\mu = 4.00$ and $\sigma = 1.10$. On the one hand, most people don't have confidence about their capability while playing the game; on the other hand, at least some are able to play the game without any help. According to the conversation with the participants, it was noticed that the participant who checked "Disagree" read through all the text during tutorial level carefully, while others kept clicking buttons "Next" without a fully understanding of the tasks.

Statement 7 description: I found the various functions in this game were well integrated. 1 person agreed with the statement, 2 persons checked "Neutral", 2 others expressed their disagreement and 1 had the opinion that was strongly against the statement. For agree score, $\mu = 2.33$ and $\sigma = 0.82$. The main functions in the game are two parts, entertainment and education. The meta game was designed for entertainment seeking, while mini games are there for educational purposes. Participants who gave a positive opinion on this statement must have noticed this. However, it was not so clear for the ones who didn't agree much on this statement.

Statement 8 description: I thought there was too much inconsistency in this game. This statement divided the subjects into to two camps. In the group that does not agree with the statement, one person's opinion was strongly against it. Among the other group with the other half people, similarly, there is one who strongly agrees with the statement. No body chose an ambiguous position. For agree score, $\mu = 3.00$ and $\sigma = 1.55$. Skipping

the tutorial levels can be a reason why participants who do not agree with the statement could not get the consistent idea about game.

Statement 9 description: I would imagine that most people would learn to use this game very quickly. It looks like the subjects were not confident about letting new users play this game directly. Because the data reveals that 4 participants disagreeing on this statement and the other 2 strongly disagreeing with it. For agree score, $\mu = 1.67$ and $\sigma = 0.52$.

Statement 10 description: I felt very confident using the game. Similar to the result of statement 9, four participants disagreed and the rest of them checked "Strongly Disagree". For agree score, $\mu = 1.67$ and $\sigma = 0.52$. Participants' attitude towards statement 9 and 10 revealed one thing: when players are playing the game, they have a large feeling of uncertainty about their behaviors in game.

Statement 11 description: I needed to learn a lot before I could get going with this game. The data from this statement question is diverse. Half of the participants strongly agreed with this statement, 1 person agreed with it at a lower level. For agree score, $\mu = 3.67$ and $\sigma = 1.75$. The interesting part is that another participant think this statement is against her feeling and the last participant didn't agree with at a high level. It is normal that people may have different feelings on the same thing. However, what caused this result was still players' choice of doing or not doing tutorial.

4.3.2   Finger Movement

The purpose of taking videos is to watch and analyze player's finger behaviors during game play. In this section, important feedbacks and issue are illustrated.

All of the 7 participants loved the art assets. All of them were amazed at the first sight of the game, that of the mountain scene with moving suns. As player moves on, art assets including clients, counsellors and backgrounds are seen. No negative feedback was received from the players about them.

It is very unclear what the player is expected to do when recruiting clients. Though there are icons with different directions designed to tell the player to "swipe to play", most players began with tapping on the icons. Even if they succeeded in swiping, they still have no idea as to why they did it.

In meta tutorial level, many participants preferred to directly click the button "Next" at the first moment when it was enabled without reading instruction text. As mentioned by one of the teachers, children don't like to read and simply click "Next" till the end.

The first reaction everyone does when seeing new information is tapping. People always want to tap on things even though nothing has happened after several tries. For example, it was noticed that when a job offer appears from the left part of screen while player is playing on the tutorial level for mini game, she tapped and held to view the detailed information for that job before being instructed to do so. Tap and hold is something that people can do without teaching.

4.3.3   Transcript

Transcripts are made from the audio-visual files, using which the researcher is able to better understand the subjects' feeling and experience. Within this section, the key notes in the transcripts are discussed.

Feedback from one of the teachers was that the name of the icon was different from the name of the game. Name of the icon was "Go Places" but name of game was "The Places You'll Go"". Consistency with respect to the icon and the game will be helpful

"The art is so cute!" is always heard from the participants. This sentence can be a description for clients, counsellors and any art-related assets. We have an excellent artist in the team and the game`s artwork is more than adequate for now.

For some players, it was hard to realize their location in the game. For example, some of them said with surprise, "That was just the tutorial?", when she finished the tutorial level and had just started the mini game.

Some indicators like arrows are not clear. For instance, arrows can be representing either tapping or swiping, which can confuse the player.

Though people are collecting energy items like burgers, some of them do not know the use of it. According to their words, they collect them simply because there are items falling down and they could not stop tapping them. It was hard for them to build the relationship between energy and the consumption of planting tools.

4.4   Summary

This chapter discussed the results of the study. Software procedure was discussed technically, including game structure and problems. Reports from subjects and their background were introduced. Based on the positive and negative feedback and analysis results, the usability scale of the game is clearly analyzed in the followed section from three angles: statements, videos and transcripts. There was no significant evidence proved the relationship between user's opinion and her demographic information.

CHAPTER 5. DISCUSSION

5.1   Research Limitations

No educational outcome was evaluated. Because the research was designed and

conducted to answer the original research question: Does TPYG, as an educational game,

provides a good user experience when user interacts with the product for the first time?

The goal of the research is to provide a valid and constructive suggestion for future

development. However, this is a serious game developed for educational purposes. The

educational functions of the game were not studied through the experiment.

Test subjects are not the exact future targeted users. Target users of the game were

students who are looking to enter college or are graduating. However, the subjects in this

study were not the target group. We invited teachers to participate in the study because of

their experience in education and communication with students. Because they know a lot

about students, their suggestions are more valuable that could guide future development

in some aspects. Thus, we lack data about target users. In the future, target users will be

collected and tested for the next development iteration.

5.2   Usability Test Indication

The game design was complex. This is the main problem of TPYG. We found that

there are 4 major factors that caused its complexity:

1. Low efficient tutorial level, which made participants unconfident when playing. There are two tutorial levels, one is for the meta game and other one is for the first mini game. The major problems in the first tutorial level are that: plan text is not welcomed and players keep clicking "Next" to make the tutorial procedure faster. In the mini game tutorial, complains were mainly focused on discontinuous game content, slow progress and plain text.

2. Indicators misled player. Existing indicators have ambiguous meanings, missing indicators in some places and unclear indicators are three issues found among indicators. For example, swiping to recruit clients does not help.

3. Tedious steps before getting started is a waste of player's attention. Participants were all excited at the beginning of gaming. However, as times goes, they lose their patience gradually. Things got worse when the tutorial didn't actually help a bit.

4. Too much information in mini game is a burden for player. Player is required to learn about concept, client, counsellor, job offer, tools, energy, grid map and the meaning of matching value before mini game. It was hard to learn all such prerequisite knowledge in a short time. However, without it, player feels lost in the game.

There are other conclusions that need to be mentioned. Functions of the game are clear, though with some design issues. Everyone noticed the design of meta game and mini game. Mini game was the place where players spent most of their time on. Art was friendly to users, though some players had occasional suggestions about sprites' color.

5.3   Future Work

Valuable suggestions were collected for future development. In future work, we should keep what most people like and optimize any low efficient designs. There are four major problems need to be fixed for next iteration:

1. Tutorial levels need to be simplified, optimized and even removed. One way to do this is to put tutorial contents into levels.

2. Simplify the meta game mechanism. Unlocking counsellors and recruiting clients are two functions that can be modified in a large scale. In the future, player get all the counsellors at the beginning of the game and are allowed to pick the favorite one. The only difference between counsellors is appearance. Recruiting clients can be put into the mini game as a part of it, so that it will not cause confusion. While recruiting clients, player will have time learn about their clients.

3. Simplify the mini game mechanism. Some functions that are not helpful to improve player experience should be completely removed, Energy collecting is one such example. Also, we should reduce the quantity of clients. For now, there are five. But in the future, the number should be reduced to only one.

4. We should take more advantage of the device, most iOS devices after 2012 are equipped with advanced accelerometer and gyroscope. Using built-in sensors will provide an easier way for players to manipulate.

Besides the work on software development, test on target users should be done soon. However, to get better results, the next usability test on the group who are the game's potential users should be conducted after all the problems have been fixed during the next development iteration.

5.4   Conclusion

TPYG was one possible solution to visualize job matching relationship by interpreting raw data. It was a game designed for demonstrating career matching data to its users. We conducted the study to find the answer to the question: Does the game TPYG, as an educational game, provides a good user experience when user interacts with it for the first time? It is valuable to find that the answer to the question is "No". Important suggestions were collected, while feasible and scientific plans were made according to the result of this study.

The steps for the study was: game implementation, usability test and result analysis. The study discussed about the procedure of developing the game and the method we used to conduct the experiment on 7 participants.

From the result of this study, we discovered principles of making a game with good gaming experience. With limitations, general conclusions can be used universally in most cases of game development.

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APPENDICES

Appendix A   Consent Form

RESEARCH PARTICIPANT CONSENT FORM
A Serious Game for Career Education and Exploration
Dr. David M. Whittinghill, Principal Investigator
Computer Graphics Technology
Purdue University

What is the purpose of this study?

This study will investigate the usability of a serious game that was developed to help students select a major that fits their skills, values, and interests. Students and teachers beliefs and perceptions about video games are key factors that influence their use of this technology. Therefore, the aim of this study is to test the usability of a serious game that was developed to help students find the right major that meets their personal and academic goals and interests, and leads to a satisfying career.

What will I do if I choose to be in this study?

During the session, you will be asked to play an educational game, and think aloud to provide statements on what you are thinking while playing the game. Your answers/feedback will be recorded. The testing session will be videotaped just to record your input/interactions while you are playing the game. The videos will be used to help us accurately transcribe your responses, and improve the usability of the game. Your face will not be recorded, so you will not be identified. You will complete a survey after playing the educational game in order to determine your attitude towards the usability of the game.

How long will I be in the study?

The surveys will have a duration of approximately 10 minutes each.
The gameplay will have a duration of approximately 40 minutes.

What are the possible risks or discomforts?

There are only minimal risks associated with this study. The standard for minimal risk is that which is found in everyday life. However, breach of confidentiality is a risk associated with research. We have taken the following measures to protect and maintain your confidentiality: assigning a code instead of names to the data collected during the study and locking any research records in an office where only the investigators have access.

Are there any potential benefits?

There are no direct benefits for participating in this research study.

Will I receive payment or other incentive?

For your time, a $50/hour stipend will be paid.

Will information about me and my participation be kept confidential?

Yes, your participation will be kept confidential. No one outside the research team will have access to the information collected during the duration of this study. Data will be anonymized and only the investigators will have access to the data. Random number identities and pseudonyms will be assigned to keep the data confidential. You will not be identified by name in any report of any research reports

in connection with any type of data connected with this study. All research records will be kept on campus in the locked office of the Principal Investigator. Signed consent forms will be kept in a separate location from the research data, and will be kept for 3 year once the study is closed.

Who can I contact if I have questions about the study?

If you have questions, comments or concerns about this research project, you can talk to one of the researchers. Please contact Dr. David Whittinghill, principal investigator at dmwhittinghill@purdue.edu or you might call him at 765-494-1353.

If you have questions about your rights while taking part in the study or have concerns about the treatment of research participants, please call the Human Research Protection Program at (765) 494-5942, email (irb@purdue.edu)or write to:
> Human Research Protection Program - Purdue University
> Ernest C. Young Hall, Room 1032
> 155 S. Grant St.,
> West Lafayette, IN 47907-2114

Documentation of Informed Consent

If you wish to participate in this study, please sign the form below. A signature will indicate agreement to participate. Your participation is voluntary and you can withdraw from the study at any time without penalty.

Participant's Name: (Print) _____

Signature _____ (Date) _____

Appendix B   Survey

Demographic information
1. What is your age?

• 19 or under	• 20- 29
• 30- 39	• 40 or older

2. What is your gender?

• Female	• Male

3. What is the highest degree or level of school you have completed?

• Some college credit, no degree	• Bachelor's degree
• Master's degree	• Professional degree
• Doctorate degree	• Other (please specify)

4. Employment Status:

• Employed for wages	• Self-employed
• Out of work and looking for work	• A student
• Military	• Retired
• Other (please specify)	

Please indicate how much you agree or disagree with each of the following statements:

#	Item	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
1	I found the game fun, with no repetitive or boring tasks.					
2	The purpose of the game is clear.					
3	I think that I would like to play this game frequently.					
4	I found the game unnecessarily complex.					
5	I thought the game was easy to use.					
6	I think that I would need the support of another person to be able to play this game.					
7	I found the various functions in this game were well integrated.					
8	I thought there was too much inconsistency in this game.					

Table continued

9	**I would imagine that most people would learn to use this game very quickly.**					
10	I felt very confident using the game.					
11	I needed to learn a lot of things before I could get going with this game.					