THE EFFECT OF GAME ENVIRONMENTS AND STUDENTS' COMPUTER LITERACY PERCEPTIONS ON THEIR LEARNING OF MULTIMEDIA DESIGN PRINCIPLES AND LEARNING ENVIRONMENT SELECTION

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Thesis Abstract

Oğuz Ak, “The Effect of Game Environments and Students’ Computer Literacy Perceptions on Their Learning of Multimedia Design Principles and Learning Environment Selection”

Although games are typically thought of as a good potential medium for learning, their effectiveness in educational settings has been largely insufficiently studied. This study was conducted on the Faculty of Education students' learning of the “Principles of Multimedia Design” learning unit in 3 separate learning environments which were traditional, 2D and 3D game-based learning environments to test their effectiveness. The main purposes of this study include: investigating the effect of students' computer literacy perceptions on their achievement and learning environment selection scores in the three environments, identifying effectiveness of environments in students' learning gain, and finding the most suitable environment(s) in terms of learning gains and student preferences.

To test these research questions an experimental research design was used. Sixty students were divided into 3 groups , The traditional learning group study the content as 20 students in traditional learning environment, 2D learning group study it as 21 students in 2D game learning environment, and in the 3D game study it as 19 students in 3D game learning environment.

As a result of the study it was determined that computer literacy perception does not have any relation with students learning gain or their learning environment selection scores. Moreover, it was determined that all groups made significant learning gains, but none of the learning environments resulted in greater learning gains than the others. Finally the students’ preferred learning environment is determined as 2D games learning environment.

Tez Özeti

Oğuz Ak, "Oyun Ortamlarının ve Öğrencilerin Bilgisayar Okuryazarlığı Algılarının, Çokluortam Tasarım İlkeleri Konusundaki Başarılarına ve Öğrenme Ortamı Seçimlerine Etkisi"

Bilgisayar oyunlarının iyi bir eğitim aracı olduğu düşünülmesine rağmen eğitsel ortamlardaki etkinlikleri belirgin değildir. Bu çalışmada, Eğitim Fakültesi öğrencileri, oyunların eğitimdeki etkinliğinin ölçülmesi amacıyla Çokluortam Tasarımı İlkeleri konusunu 3 farklı öğrenme ortamında işlemişlerdir. Bu ortamlar geleneksel, 2 boyutlu ve 3 boyutlu oyun öğrenme ortamlarıdır. Çalışmanın temel amaçları; her 3 ortamda öğrencilerin bilgisayar okuryazarlığı algıları ile konu başarıları ve öğrenme ortamı seçimleri arasındaki ilişkileri araştırmak, öğrenme ortamlarının öğrencinin başarısına katkısını, bu ortamların birbirine göre başarı açısından etkinliğini ve öğrencilerin en çok tercih ettikleri öğrenme ortam(lar)ını tespit etmektir.

Araştırmadaki soruları test etmek amacıyla deneysel çalışma deseni kullanılmıştır. Çalışmaya katılan 60 öğrenci 3 gruba ayrılmıştır; geleneksel öğrenme grubu konuyu 20 öğrenci olarak geleneksel öğrenme ortamında, 2 boyutlu öğrenme grubu 21 öğrenci olarak 2 boyutlu oyun öğrenme ortamında, 3 boyutlu öğrenme grubu 19 öğrenci olarak 3 boyutlu oyun öğrenme ortamında çalışmıştır.

Çalışma sonuçlarına göre, öğrencilerin bilgisayar okuryazarlığı algısı ile ilgili konudaki öğrenme düzeyleri ve öğrenme ortamı seçimleri arasında bir ilişki bulunamamıştır. Öte yandan her 3 ortamda da öğrenciler anlamlı şekilde konu bilgilerini arttırmışlar fakat bu artışlar konusunda gruplar arasında herhangi bir fark bulunanamamıştır. Son olarak öğrencilerin tercih ettikleri öğrenme ortamının 2 boyutlu oyun öğrenme ortamı olduğu belirlenmiştir.

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CHAPTER 1

INTRODUCTION

Technology, particularly computer games, is widely used among young people (Jones, 2002; Karakus, Cagiltay and Inal, 2008; Rideout, Foeh and Roberts, 2010). While the members of the new generation are exposed to new mediums researchers argue that their learning needs change (Oblinger, 2004; Oblinger and Oblinger, 2005; Prensky, 2001; Tapscott, 1999) and many researchers have reported that the existing potential of the medium can be used as a tool in education to provide various opportunities like improving students' motivation and providing better learning experiences (Gee, 2003; Lepper and Chabay, 1985; Prensky, 2001; Shaffer, 2006; Squire, 2005). Although there are existing theories and studies in the area, the effectiveness of the games in education and its' particular functions supporting learning is still questioned (Annetta, 2008; Hays, 2005; Kebritchi, Hirumi and Bai, 2010; Randel, Morris, Watzel and Whitehill, 1992). For this reason empirical studies in the area are required, including students' preferences about learning environments and the effectiveness of games in the acquisition of learning the objectives of a curriculum.

According to Jones (2002), all students from the ages of 16-18 use computers in the USA and 66 percent of college students have at least 2 email accounts. Moreover, children in the USA play average of 73 minutes of games every day (Rideout et al., 2010) and in Turkey 68% of high school students play more than 1 hour, and 19% play more than 6 hours of computer games per week (Karakus et al.,2008). So technology is widely used among students and playing games is an important part of their lives. According to Gartner Inc. (2011) about 67 billion

dollars were spent in the gaming industry worldwide in 2010, and according to the BBC (2012) the gaming industry was the biggest entertainment industry in the UK in 2011. These values indicate that games are becoming increasingly a global phenomenon.

Squire (2003) states that video games are the first and most popular digital medium, and they are listed as the most important and influential medium for people who are less than 35 years old (Squire, 2005). Importantly for this study, because games have the power to engage students and provide virtual worlds they can be used in education (Gee, 2003; Prensky, 2003).

According to Garris et al. (2002) professionals list 3 reasons for using games in education which are: a need for adopting the shift of traditional to learner-centered education; games can be effective tools for enhancing learning and understanding complex subjects; and games are good for training personnel by engaging them. Similarly, many authors point to game usage in education, because as the new generation grows up with digital technologies, their needs change and games are increasingly a useful tool to teach them (Frand, 2000; Prensky, 2001; Shaffer and Gee, 2005). In this manner, Shaffer and Gee (2005) report that recent research indicates that even a student who passes typical school tests could not apply their knowledge to solve real-world problems, and according to Prensky (2001) students of the new generation do not respond to traditional learning methodologies because of their changing profiles. As a result the literature identifies games as among the future tools we may use to educate the new generation.

In order to determine the preferences of the new generation, an estimate level of technology usage of students must be determined. In this manner Berk (2010) created a scale to evaluate the level of the net generation profile with 15 yes/no

questions depending on the findings in the literature about the “net generation”. However it is thought that students’ computer literacy perception level would also be an indicator of being a member of new generation because the discriminating property of the new generation, which results in different habits and needs of learning, is the usage of new medium. So the perceived level of usage of the medium for students would indicate the degree to which one is a member of the new generation.

However, although the power of games is cited by many researchers, there is significant debate regarding their effectiveness (Annetta, 2008; Garris et al., 2002). Studies in the literature do not show consistent effectiveness of games in either motivating or teaching (Kebritchi et al., 2010; Randel et al., 1992). As a result of the confounding results from the recent attention paid to the use of video games in education, empirical studies gain more importance (Annetta, 2008).

In the literature there is an effort to analyze what education-specific games might look like. Many researchers have tried to separate out the various properties of games like challenge, fantasy, rules and goals, curiosity, control, feedback, social interaction, immersion etc. (Bonanno and Kommers, 2007; Csikszentmihalyi, 1990; Dondi and Moretti, 2007; Fang, Chan, Brzezinski, Nair, 2010; Fu, Su, Yu, 2009; Garris et al., 2002; Kiili, 2005; Malone, 1980; Malone and Lepper, 1987; Sherry, Lucas, Greenberg and Lachlan, 2006; Squires and Preece, 1999; Sweetser and Wyeth, 2005). Although the above list of the properties of games is long, defining the quality in games seems the specifics of these definitions continue to be a challenging issue. In addition to these qualifications, the effectiveness of games in education may depend on the genre (quiz, action, role play etc.) or type of games (either 2D or 3D). It seems there has been some little effort to compare 2D and 3D

environments in the literature. However, one interesting way forward suggested by researchers for different types of learning objectives or learning groups is for different types of learning games depending on the educational goals (Dondi and Moretti, 2007; Hays, 2005; Prensky, 2001). So the effect of game type and game environment would be other important factors of determining the educational quality of games.

Moreover, as a learning unit of this study, 'the principles of multimedia design' is selected for the university level. Mayer (2001, 2009) developed his cognitive theory of multimedia design and using this theory he listed his principles of multimedia design. The core idea behind these principles is that the "use of multimedia" supports learning when it is designed according to a set of stated rules. So Mayer's principle of multimedia design is an important issue for the development of instructional materials. Although comprehensive studies of the teaching of the multimedia design principle have not been performed as yet, the effectiveness of the principles is shown through the exploration of related studies. For example, Issa et al. (2011) shows that when the content is prepared according to these principles for medical students it improves their short term retention.

To sum up, according to findings from the literature, the effectiveness of games in education is not clear, but it generally suggests that the new generation would be better served through this type of education rather than traditional education. Because of these issues, the new generations' preferences for different learning environments gain importance. In this manner, an indicator of being a member of the new generation computer literacy perception could be used. Moreover the effectiveness of games may be related to the type of the learning environment more compatible with either 2D or 3D and the specific genre of the game. So the

effect of learning environment and the effect of ‘quiz game’ in learning should be studied. For this study as a research subject Principles of Multimedia Learning is chosen because it is an important subject for educational material development area.

CHAPTER 2

REVIEW OF LITERATURE

The Use of Computer Games in Education

Throughout history with the evolution of technology, education has always gone through processes of change and development. Prensky (2001) states that computers create a new realm of expansion in education. He describes the main advances in education as: Education begins with a process of "imitation" in which "demonstration" takes place, then pictures and symbols are added to this learning process. The following biggest steps which affect education are spoken language, literacy, printing press and development of schools. Each of these steps was a revolution in education, according to Prensky (2001). Finally in the late twentieth century computers, interactivity and their associated technologies began to influence global education. One important and as yet underrepresented computer technologies is the use of computer games in education. So, from Prensky's (2001) point of view the use of computer games is a part of the new revolution in learning.

In the literature the key terms related to the use of games in education are: "video games", "simulations", "epistemic games", "serious games", "instructional games" and "learning games". Actually games and simulations are not the same concepts but they are sometimes confused. Simulations are defined as computer programs that models real or theoretical systems by Thomas and Hooper (1991). Another definition of a simulation is "a virtual environment that attempts to accurately replicate a task or experience for specific training or educational purposes" (Iuppa and Borst, 2009, p.13). So in simulations the primary aim is to replicate reality.

Then, Shaffer and Gee (2005) define epistemic games as the games that let players learn to work and to think as innovative professionals. In this manner Shaffer (2006) defines the concept of an ‘epistemic frame’ as “interactive learning environments that help students deal more effectively with situations outside of the original context of learning” (p.223). It represents games or interactive experiences wherein the student is able to act out the specific role of the game, such as “playing” an architect or city planner. He says that "students can incorporate these epistemic frames into their identities when engaged in extended educational role playing games" (p. 223).

Another concept in this context is "serious games". Zyda (2005) defines "serious game" as "a mental contest, played with a computer in accordance with specific rules, that uses entertainment to further government or corporate training, education, health, public policy, and strategic communication objectives" (p.25). Moreover, Iuppa and Borst (2009) identified that serious games have two purposes: transferring and reinforcing knowledge and skills and using technologies and content with the aim of changing social or personal behavior.

Moreover the concept of “a game” is defined by Hays (2005) as “an artificially constructed, competitive activity with a specific goal, a set of rules and constraints that are located in a specific context” (p.15). When the games are used in education they are identified as ‘instructional games’ which are defined as computer games designed for training or educational purposes (Kebritchi et al., 2010). The term “learning game” is defined (Dondi and Moretti, 2007) as games which have explicit informative purposes to support and foster the learning process in various learning scenarios.

Finally, because the simulations and games are confused so often there is a need to separate them. While simulation is an open-ended environment including little game elements, game is a closed environment with clear rules, goals, and measurements of success or failure in achieving goals (Iuppa and Borst, 2009). So, "simulations with game elements are always serious games but serious games do not need to be simulations" (Iuppa and Borst, 2009, p.14).

According to Rideout et al. (2010) which is a Kaiser Family Foundation study in the USA, kids play 73 minutes of video games a day and young people between 8 and 18 spend a great amount of time with games and various related media sources. Also according to Jones (2003), 69% of students play games after they reach the ages of elementary school students, 77% play since high school age, and after high school 60% are regular game players with an average game play age of 29. In Turkey, the young generation also spends a considerable amount of time with related media. According to Karakus, Cagiltay and Inal (2008) among the college students in Turkey 38.4% of males play more than 6 hours of computer games a week and 88.5% of females play 1-5 hours of games in a week. So, game play is an irreconcilable part of young peoples' lives. One of the main debates about games is whether using the potential of games in classes is effective or not.

On one side games are seen as fun and engaging and they can be used in education (Annetta, 2008; Prensky, 2001; Squire, 2003) but their potential has often been ignored by educators (Prensky,2001; Squire, 2003; Virvou et al., 2005). One reason for games not reaching schools is the prejudice of educators and the other is the criticism about the quality of the existing educational games (Virvou, et al. 2005). Annetta (2008) and Squire (2003) argue that the existing attempts to use

games in empirical environments are not adequate and that there is a need to further investigate their effectiveness in the school setting.

On the other side some criticism arises about game usage in education. According to Tüzün (2007) one challenge for any engagement with games for learning is that there is a need to balance the engagement and learning because some students lose their attention to the learning content by concentrating more on the entertainment side. While there is this stated concern that some students will be too distracted by their interest in the entertainment side of games, there is the dichotomist criticism that perhaps they might not be drawn into using games in the first place, or that they may find the usage of games difficult (Virvou et al., 2005). Also, Bourgonjon et al. (2010) argue that the immersion in games is just the desire of students to communicate with friends to search for a meaning of having fun. So they state that maybe the usage of games in learning is therefore exaggerated. So there are also some counter arguments about the effectiveness of games. In addition, Annetta (2008) argues that potential of games on motivation and interest is high but their effectiveness in learning has not yet been established to a satisfactory degree. Prensky (2001) disagrees with this argument and suggests that "game based learning" as such a broadly defined concept is not to blame, but the problem is probably the fault of design flaws of particular games that result in stultified learning.

The empirical studies explain different results. Apart from theory, in one study Randel et al. (1992) produced an illuminating review of the literature of game applications. They found that among the 46 studies in social sciences (specifically: history, geography, economics, educational psychology, politics, careers and map reading), 33 of the games studied did not show any difference in students' learning,

10 studies showed the success in game based learning and 3 of them were in favor of traditional learning. A similar study done by Kebritchi et al. (2010), analyzed 16 game usage studies done in the years between 1996-2009 in various areas like mathematics and science. Among 16 of them, 9 studies improved learners' achievement, 4 studies improved learners' motivation and no differences were found in learners' achievement and motivation in 5 of the studies. Moreover, Kebritchi et al. (2010) tested their game with 193 students in mathematics and found that their game improved students' achievement but not their motivation.

So as the studies show, the effectiveness of games in learning and motivation is heavily debated. This picture is also shown by Hays (2005): he reviewed the existing articles about game usage in education and chose 169 game articles for design, usage and the evaluation of games. He concluded that while games certainly have the potential to be effective in a variety of ways, it should not be generalized from one group of learners to another. Effectiveness in one study does not mean that the games will be effective in all tasks to all learners. Moreover he also concludes that there is no evidence to indicate that games are the preferred instructional method in all situations. The determination of game use should be based on a detailed analysis of the learning requirements.

So as a result of these findings, it is evident that the effectiveness of games is not clear for tasks or student groups. There is a need to study the particular elements of games in learning settings to prove or disprove the effectiveness of games in various tasks and groups.

Comparison of 2D and 3D Game Effectiveness

Another debate in game based learning is the effectiveness according to game environment. Educational games are created as either 2 dimensional or 3 dimensional. Three dimensional games are relatively a newer technology. The effectiveness of the two environments is compared in some studies, for example Virvou et al. (2005) compared a simple 2D intelligent tutoring system with a 3D virtual reality game on students' mistakes of geography subjects and found that the experiment group had a greater improvement with 10.67% fewer mistakes than the control group. In short, the 3D virtual reality game had significantly better results in terms of learning. However, this does not mean that 3D games should be considered as the preferred instructional method in all scenarios, as mentioned by Hays (2005). He found that it is wrong to generalize the effectiveness of games from one case to another. For example, when Elliot et al. (2002) used a 3D game environment for the exploration of 3D mathematics concepts, they found no differences between the experiment and control group, even 4 of the 8 participants reported that they did not find the game environment helpful in learning the content material.

Moreover, in a study Arya et al. (n. d.) applied an archeology work in both 2D and 3D game environments. They took participants' views about the environments depending on students' (anecdotal) views. The results showed that students found the 3D environment more helpful and that that environment was better for fostering learning. So in order to see the differences between the two environments we appear to be in need of further research.

Defining Quality in Educational Computer Games

As the previous sections indicate, there is a need to analyze the specific ways in which games can be broken down into their specific components and features and what the most effective components of games might be to affect learning and motivation. In the literature, there have been many attempts to define the ability of "games" to increase learning but according to Garris et al. (2002) there is not a common consensus about which features of games result in learning. Dondi and Moretti (2007) state that there is still a need to create a culture of "quality" for learning games. In this manner, as mentioned before, the effectiveness of computer games depend on their design (Hays, 2005; Prensky, 2001). So what are the particular design elements which make games better in terms of learning and motivation?

In the literature some scientists attempt to define the particular functions of games in order to determine which functions are most effective in terms of learning or motivation (Bonanno and Kommers, 2007; Csikszentmihalyi, 1990; Dondi and Moretti, 2007; Fang, Chan, Brzezinski, Nair, 2010; Fu, Su, Yu, 2009; Garris et al., 2002; Kiili, 2005; Malone, 1980; Malone and Lepper, 1987; Sherry, Lucas, Greenberg and Lachlan, 2006; Squires and Preece, 1999; Sweetser and Wyeth, 2005). Table 1 represents a compilation of the different ways the common features have been defined in the relevant literature.

Table 1. Game Concepts, Their Definitions and Related Literature

Concept	General Definition	Related Literature
Challenge	Optimal level of difficulty; the game should not be too difficult or too easy.	Csikszentmihalyi, 1990; Fu, Su, Yu, 2009; Garris and Ahlers, 2002; Kiili, 2005; Malone, 1980; Malone and Lepper, 1987; Sherry, Lucas, Greenberg, Lachlan, 2006; Sweetser and Wyeth, 2005;
Fantasy	The environment that evokes mental images or some situations which actually do not exist.	Garris et al., 2002; Malone, 1980; Malone and Lepper, 1987; Sherry, Lucas, Greenberg, Lachlan, 2006;
Rules/goals	Game activities occur in a fixed space and time period with precise rules governing game play.	Csikszentmihalyi, 1990; Fu, Su, Yu, 2009; Garris et al., 2002; Kiili, 2005; Malone, 1980; Sweetser and Wyeth, 2005;
Mystery / Curiosity	Mystery is the action which results in curiosity. Curiosity is a product of perceived discrepancies or inconsistencies in our knowledge.	Garris et al., 2002; Malone, 1980; Malone and Lepper, 1987;
Control	Exercising authority or the ability to regulate something.	Csikszentmihalyi, 1990; Fu, Su, Yu, 2009; Garris et al., 2002; Malone and Lepper, 1987; Sweetser and Wyeth, 2005;
Sensory stimuli	Sound effects, dynamic graphics and other sensory stimuli which are strange or unfamiliar.	Garris et al., 2002;
Feedback	Allow players to determine the gap between the current stage of knowledge and the knowledge required for ultimate completion of the game's task.	Csikszentmihalyi, 1990; Fu, Su, Yu, 2009; Kiili, 2005; Sweetser and Wyeth, 2005;

Table 1. Game Concepts, Their Definitions and Related Literature (continued)

Concept	General Definition	Related Literature
Engaging storyline	The story should be simple, but its' meaning should be immersing, engaging and educating.	Kiili, 2005;
Game balance	Challenges should be balanced so that games difficulty increases incrementally not spike irregularly.	Kiili, 2005;
Social Interaction / player interaction	Task in the game should be a means for players to interact socially.	Fu, Su, Yu, 2009; Sherry, Lucas, Greenberg, Lachlan, 2006; Sweetser and Wyeth, 2005;
Diversion	Video games are used to avoid stress or responsibilities, the function of them is providing relaxation and escaping from stress.	Sherry, Lucas, Greenberg, Lachlan, 2006;
Competition	Proving to other people that the person has the best skills in game and s/he can react or think fastest.	Malone and Lepper, 1987; Sherry, Lucas, Greenberg, Lachlan, 2006;
Arousal	Playing video games stimulate emotions as a result of fast action and high quality graphics.	Sherry, Lucas, Greenberg, Lachlan, 2006;
Immersion / loss of self-consciousness	The game should lead the player into a state of immersion.	Csikszentmihalyi, 1990; Fu, Su, Yu, 2009; Sweetser and Wyeth, 2005;

Table 1. Game Concepts, Their Definitions and Related Literature (continued)

Concept	General Definition	Related Literature
Concentration	Activities in game should encourage the player's concentration while minimizing the cognitive load.	Fu, Su, Yu, 2009; Sweetser and Wyeth, 2005;
Skill	Perceived skills should match challenges.	Csikszentmihalyi, 1990; Sweetser and Wyeth, 2005;
Autonomy	The learners should enjoy taking the initiative in game-play by asserting total control over his/her choices.	Fu, Su, Yu, 2009;
Cooperation	Combining scores of a group of students in games or broking down the task in the game to a group of students.	Malone and Lepper, 1987;
Recognition	People enjoy when their efforts and accomplishments are recognized by others.	Malone and Lepper, 1987;
Transformation of time	Time no longer seems to pass the way it ordinarily does in games.	Csikszentmihalyi, 1990;
Knowledge improvement	The game increases players' level of knowledge and skills while meeting the goal of the curriculum.	Fu, Su, Yu, 2009;

The listed concepts show different elements of games in education. Although different researchers explain a “good” game using different terms, their main aim is to define what makes games either enjoyable or valuable or both in education. For that purpose Malone (1980) argues that a good game should provide challenge, fantasy and curiosity. In his explanation, a challenge includes clear goals, uncertain outcomes and providing self-esteem, and curiosity including sensory and cognitive curiosities. He states that when these elements are provided in games, they make

games enjoyable. In line with this a companion list of heuristics are defined by Malone and Lepper (1987) which are challenge, curiosity, control, fantasy, cooperation, competition and recognition.

Csikszentmihalyi (1990) argues that the concept which results in engagement in games is 'flow'. According to him flow is a general concept of psychology and it is defined as "the order in consciousness"(Csikszentmihalyi, 1990). In a flow state attention can be freely invested to achieve one's goal because no disorders and threats exist. According to Csikszentmihalyi (1990), elements of flow is a challenging activity that requires skills, concentration on the task at hand, paradox of control, the loss of self-consciousness and the transformation of time. By using these heuristics and related literature, Sweetser and Wyeth (2005) created a model to evaluate players' enjoyment in games which they named “GameFlow”. GameFlow consists of 8 heuristics: concentration, challenge, player skills, control, clear goals, feedback, immersion and social interaction. Using this study Fu, Su, and Yu (2009) created an instrument to evaluate e-learning games and they called this EGameFlow. They used the same categorization by GameFlow but they changed the factor 'player skill' in GameFlow as 'knowledge improvement' in EGameFlow and 'control' became 'autonomy'.

Sherry et al. (2006) studied the effect of games on students and they list the properties of engaging games as competition, challenge, social interaction, diversion, fantasy and arousal. Sherry et al. (2003) also identified the primary interest in games among college students as challenge. In a similar manner Garris et al. (2002) stated that games are characterized by 6 factors: fantasy, rules and goals, sensory stimuli, challenge, mystery and control. Finally in his model Kiili (2005) insists on the importance of immediate feedback, clear goals and challenges which are matched to

player's skill level. He also states that game play is an important factor of games, and the other factors that should be taken into account are an engaging storyline, appropriate graphics and sound, and game balance (Kiili, 2005).

There have been other attempts to define the qualities of games from farther outside the box. Dondi and Moretti (2007) created a game taxonomy and in that they suggest that the quality of games is determined by 3 main factors: pedagogical and context criteria, content criteria and technical criteria. In their definition the properties of games include more than just engagement. For example the category of context criteria includes target groups, prerequisites, learning objectives, context of usage etc.; content criteria includes technical/scientific language, quality of feedback etc.; the technical criteria includes credits, probability and conformance to standard, aesthetic usage of the media, etc. Another influential attempt to list components of games which aim to determine attitudes toward games is Bananno and Kommers' (2007) study. They list the components of attitudes toward games as affective components, perceived control, perceived usefulness and behavioral components. In a similar manner Fang, Chan, Brzezinski, and Nair (2010) suggest that the enjoyment of games can be influenced by 3 factors which are affect, behavior and cognition depending on Nabi and Krcmar's (2004) tripartite model.

Moreover, Squires and Preece (1999) relate Nielsen's usability principles with cognitive and contextual authenticity and they created a table of categories. From this categorization they synthesized a list of heuristics. They suggested that heuristics are properties of a qualified game which are matching the designers and learners models, navigation fidelity requirement, appropriate level of learner control, understandable and meaningful symbolic representation, support personally significant approaches to

learning, cognitive error recognition, diagnosis and recovery cycle and need for matching with the curriculum.

As a result, there is a large amount of research that describes the quality of computer games. Depending on the findings of studies there are many separate game heuristics but they are isolated, repetitive and often contradictory (Sweetser and Wyeth, 2005). It seems the commonly stated properties of games are defining the quality of a game at a level but as Garris et al. (2002) state there is not a consensus about which features of games result in learning. So, even in situations where the specifications are less than completely clear, educational games should be developed using the above studies.

Student Preferences Regarding Learning Games

A possible determinant of game success in education would be the relationship between game design and student preferences. As listed before, one of the determinants of quality in games is the match of the designers' and learners' models (Squires and Preece, 1999). In the literature there are some student preferences that are listed in terms of their age level, sex, ideas and general tendencies (Arya, Nowlan, Sauriol, 2010 ; Bonanno and Kommers, 2007; Bourganjon et al., 2008; Can and Cagiltay, 2006; Karakus, Inal, Cagiltay, 2008; Sherry et al., 2003).

Firstly, the majority of the younger generation play games in both the USA and Turkey (Karakus, Inal & Cagiltay, 2008; Rideout et al., 2010). But among them there are some differences in terms of gender. According to Karakus et al. (2008) female students in general expect games to have instructive elements while males expect entertainment, competition and multi-player functionality. According to the

same study while males prefer sports and car games, females prefer adventure puzzles or card games. Finally according to their findings males report more time playing games than females. This finding is also supported by Bourgonjon et al. (2010), he reported the same result. On the other hand, Papastergiou (2009) looked for motivation and learning change in high school students' science lesson by playing a computer game, and he did not find any difference of girls' and boys' scores in neither achievement nor motivation.

Bourgonjon et al. (2010) tried to find students' perceptions in games in their study of 858 secondary school students. They found that usefulness, learning opportunities, ease of use, and experience were the dominant predictors of preference for video games. Gender was also a predictor but it was mediated by experience.

Moreover, Arya, Nowlan and Sauriol (2010) stated that virtual environments should be detailed enough in terms of what participants want to do. On the other hand, Virvou et al. (2005) suggested that games should be designed considering the embedded content with less emphasis on animation, text and audio, none of which aid the learning process. Kiili (2005) states that because traditional games have rich multimedia elements they may result in an extra cognitive load, so the cognitive load in games should be optimized by getting rid of irrelevant multimedia elements.

Finally, Sherry et al. (2003) found that the major reason for video game usage among college students is the challenge they provide. When he compared game usage among different school levels he found that college students spend the fewest hours in game play and he concluded that if games were created according to the level of challenge that college students need, they would play more hours. So according to this finding it could be said that the main reason to make students play games is to supply games according to their needs.

As a result, there is a difference in preferences of student's game play among different ages and different classes. Hays (2005) suggests that a game which is successful in one group of students does not mean that it will be successful in all group of students. Thus the requirements of the targeted population should be determined in the game development period.

Student Differences: Game Generation

Today's children need some new requirements because some research reports that today's children have different characteristics than previous generations (Bourgonjon et al., 2008; Frand, 2000; Dede, 2005; Howe and Strauss, 2000; Oblinger and Oblinger, 2005; Oblinger, 2004; Prensky, 2001; Tapscott, 1999).

Prensky (2001) says that with the advances in technology, the experiences and recreational interests of young people has shifted radically in the last third of the twentieth century. In the USA while a student reads at most 5,000 hours of books before leaving college, they spend over 10,000 hours playing games, sending and receiving over 200,000 emails and instant messages, talking over 10,000 hours on digital cell phones, watch television over 20,000 hours, and view over 500,000 commercials (Prensky, 2001). Data from Rideout et al. (2010) also supports this argument. According to this data, young people who are between 8-18 years old devote 7 hours and 38 minutes of their time for various entertainment media (computer, television, music player etc.). Because they also make "media multitasking", the daily time spent with media increases to 10 hours and 45 minutes. The values are increasing regularly compared to previous years. Media usage increases from 8:33 to 10:45 for 2004 to 2010. So, these students spend a significant

part of their lives using these media. Moreover media usage is also high in Turkey. Karakus et al. (2008) found that only 74 of 1224 students do not use internet in Turkey and 878 of 1224 (71.7%) students report that they play games.

Because the new generation devotes their time to media, and especially to the internet, researchers think that this new generation is different from previous generations in many ways. Prensky (2001) called this generation “digital natives”, Oblinger and Oblinger (2005) as “the net generation”, Howe and Strauss (2000) as “millennials”, Bourgonjon et al. (2008) as “contemporary students”. Although they called the new generation these different terms they explain their specifications similarly. Table 2 shows the general properties of the net generation.

Table 2. Stated Properties of the New Generation in the Literature

Property of New Generation	Related Research
Computer and technology is a part of their lives.	Dede, 2005; Frand , 2000; Oblinger, 2004; Presnky,2001; Topscott, 1999
They are staying connected through technology.	Frand, 2000; Oblinger, 2004
They are multitasking.	Dede,2005; Frand, 2000; Prensky, 2001; Topscott, 1999
They do not respond to traditional learning strategies.	Prensky, 2001
Their brains likely be physically different (as Neuroplasticity suggests) as a result of the digital input they receive when growing up.	Dede, 2005; Prensky, 2001
Although they do not have new cognitive skills their particular combination of the skills are new	Presnky, 2001
Web, cell phone, IM, mp3's, online communities are their product of life,	Oblinger, 2004
They are digital, connected, experiential, immediate, social.	Oblinger, 2004
They choose hypermedia learning rather than linear which provides random access and they prefer to validate any finding with different resources in this way.	Dede, 2005; Prensky ,2001; Topscott, 1999
They prefer construction / exploration instead of instruction.	Topscott,1999
Student centered education strategies are better for them than teacher centered education.	Topscott,1999
They prefer to navigate and use material instead observing it.	Topscott,1999
They prefer lifelong learning rather than school learning.	Topscott,1999
They prefer to learn as fun.	Topscott,1999
Their preferred media type is Napsterism (they create their own property instead of one-fits-all property).	Dede, 2005

As is understood from these findings, theories regarding the new generation parallel one another. The common theme is that the new generation is different from previous one and their education should be prepared according to their needs. Previously, one generation was called as 'baby boomers': people who were born between 1946-1964 (Dede, 2005; Oblinger, 2004). This generation was different because they grew up

with television and their needs were different. Just like that the new generation is called “millennials” (or “net generation”); the ones who were born after 1984, because they grew up with the internet (Dede, 2005). Dede (2005) explained that while baby boomers accept a single truth which is given on television, millennials search the resources like internet to discover and double check truths. Similarly Oblinger (2004) compared the two generations and the generation between the two as “generation X”. He argues that in baby boomers the dominant themes are: television, typewriters, telephone, memos, and family focus. In generation X the dominant themes are: video games, PC, email, CDs, and individualism. In the net generation issues are: web, cell phone, IM, mp3s, and online communities.

As they spend a considerable time (Rideout et al., 2010) on media and they have grown up with the technology their brains work differently than previous generations (Dede, 2005; Prensky, 2001). So it is not surprising that they do not respond to traditional learning methods (Prensky, 2001). According to Tapscott (1999) for this generation the preferred learning style is construction and discovery; they want to learn by doing, they want to learn in lifelong learning and they need customized learning. Similarly Oblinger (2005) suggests that learning experientially, learning with peer-to-peer learning approaches, creating opportunities for synthesizing and informal learning would be better for the generation.

Although there are many theories and suggestions about the profile of the new generation, it seems there are not enough empirical studies about them. So in order to measure their relation with computers and associated technologies a computer literacy perception level could be used.

Cognitive Theory of Multimedia Learning

The cognitive theory of multimedia is formulated and supported with studies by Mayer (2001, 2009). The theory builds on three assumptions which are dual channels, limited capacity and active processing assumptions. The theory defines 8 principles related to multimedia usage which are the multimedia principle, the contiguity principle, the coherence principle, the modality principle, the redundancy principle, the personalization effect, the interactivity principle and the signaling principle (Mayer 2001, 2009).

According to Mayer (2001) people have 2 channels for learning which are auditory/verbal channel and visual/pictorial channels. The first assumption which is the dual channel assumption explains that information is processed in these two channels. The second assumption which is the limited capacity assumption explains that information carrying capacity in each channel is limited. Finally the third assumption which is the active processing assumption explains that people can actively engage in cognitive processing to construct a coherent mental representation of their experiences. Depending on these 3 assumptions Figure 1 shows the human information processing system (Mayer, 2001).

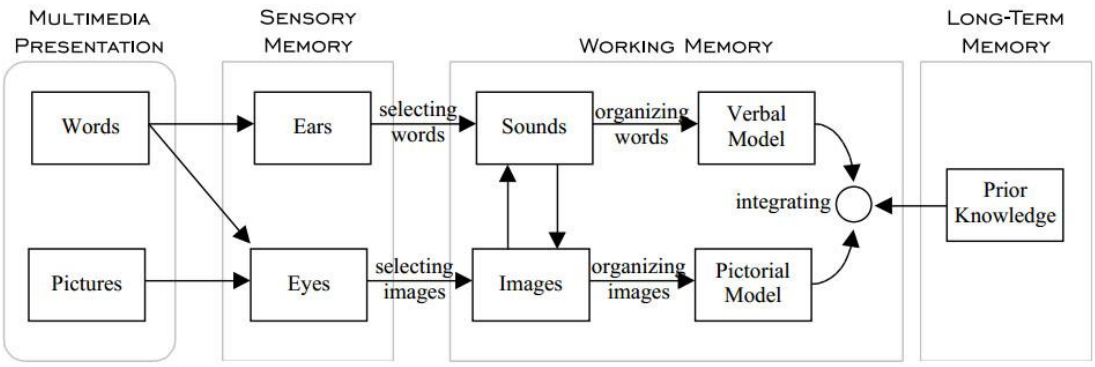


Figure 1. Human information processing system (Mayer, 2001)

In Figure 1 the line at the top part shows the auditory channel and the line at the bottom part shows the pictorial channel. By using these two channels, information coming from the multimedia presentation come from the sensory memory and go to the working memory. By organizing images and words, verbal and pictorial models are created and they integrate with prior knowledge in the long term memory. In this way learning occurs.

Depending on the cognitive theory of multimedia design, Mayer (2001) listed 8 principles for a successful multimedia design which are listed in Table 3.

Table 3. Principles of Multimedia Design (Mayer, 2001, 2009)

1. Multimedia Principle	Students learn better from words and pictures than from words alone.
2. Contiguity Principle	Students learn more deeply from multimedia presentations which animation and narration are presented simultaneously rather than successively.
3. Coherence Principle	Students learn more deeply from multimedia representations in which extraneous words, sounds, and video are excluded rather than included.
4. Modality Principle	Students learn more deeply from animation and narration than from animation and on-screen text.
5. Redundancy Principle	Students learn more deeply from multimedia presentations consisting of animation and narration than from animation, narration, and on-screen text.
6. Personalization effect	Students learn more deeply when words are presented in a conversation style than in an expository style.
7. Interactivity principle	Students learn more deeply when they can control the presentation rate of multimedia explanations than when they cannot.
8. Signaling principle	Students learn more deeply when multimedia explanations are signaled rather than non-signaled.

As a result, using the assumptions of the cognitive theory of multimedia learning, Mayer (2001, 2009) lists 8 principles to create an effective multimedia learning platform.

CHAPTER 3

STATEMENT OF THE PROBLEM

Although literature includes many studies about the particular properties of games which make them valuable for educational purposes, there is still a need for more empirical studies. Most necessary, the effect of the environment factor is has not been studied to a satisfactory degree. One of the primary aims of this study is to create 2D and 3D quiz games with the same scenario and apply it to two groups of students from the Faculty of Education to see where their preferences lie between these two environments with a comparison of traditional learning environment group.

Secondly, the effectiveness of computer games in the literature is questioned in terms of their effect on learning. For game effectiveness, two computer games will be played by two groups of students and their achievement levels and the achievement level of traditional learning group will be analyzed and then compared with one another.

Moreover, in the literature there are many theories about the changing learning needs of the current generation. However, there is still a need for empirical studies about the perceived computer literacy effect on students' achievement and environment selection. Thus, final aim of this study is to see the effect of perceived computer literacy of students on their achievement level and on their learning environment selection.

The current study is conducted in order to test these problems.

CHAPTER 4

METHOD

In this chapter, the methodology of the study will be presented. Initially, the overall design of the study will be illustrated, then research questions will be listed with the related definitions of variables. After that, the subjects of research and research application settings will be explained. Moreover, the games and data collection instruments which were developed for the research will be described. Finally, the data collection procedures and application details for the pilot and the main applications will be illustrated in detail.

Overall Design of the Study

In order to test the research questions, an experimental research design is used. The specific research process design of the study is shown in Figure 2. In the process there are 3 separate groups, each will study the learning content, "Mayer's Multimedia Design Principles", in different learning environments. The first group is the traditional learning environment group (tradLG) and they will study the learning unit in a traditional learning environment (TLE). The TLE in our case is a classroom environment in which a teacher illustrates the content using the method of presentation. The second group is a 2 dimensional game based learning group (2DGLG) which will study the same learning unit with a 2 dimensional game based learning environment (2DGLE). This group will study the content in a computer laboratory by playing two 2 dimensional flash games. The first game includes some help animations while the second game does not. Thus the first game includes some tutorial functions rather than being a simple quiz game. Finally, the third group is a 3

dimensional game base learning group (3DGLG) which will study the same learning unit in a 3 dimensional game based learning environment (3DGLE). This group will study one 2 dimensional game (the same game as the 2D game environment) first, and then a 3 dimensional game which was developed in Avaya web.alive (it is a 3d environment development platform) environment and is just an adaptation of the second 2D game in a 3D game environment. This game does not have any additional features other than an environment change. The details of the games and learning environments will be illustrated in the following chapters.

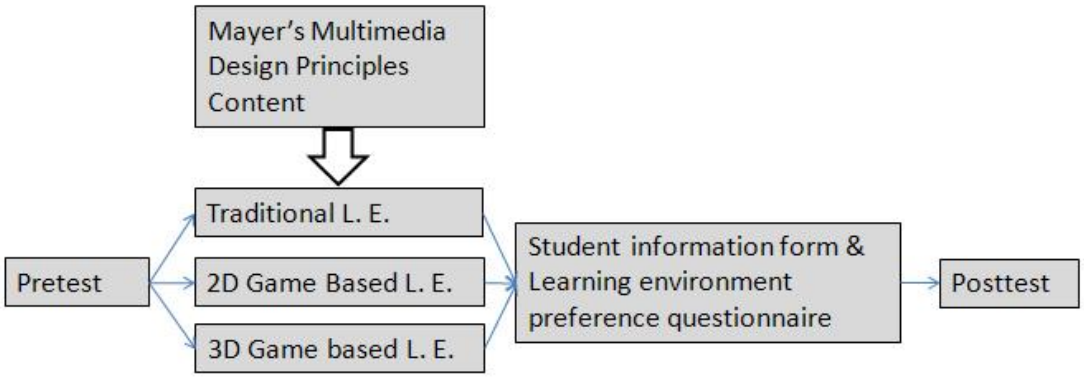


Figure 2. Research process design.

Each group will take a pretest first. The pretest is an achievement test about "Mayer's Multimedia Learning Principles" learning unit. The "pretest" includes 13 multiple choice questions and is an achievement test. Then, they will take the learning content with their specific learning environments which are TLE, 2DGLE and 3DGLE. After the learning sessions, students in each environment will take two instruments which are student information form and a learning environment preference questionnaire. Both of the forms were developed by the author by taking some items from existing scales and using information from the literature. The "student information form" will collect the students' general personal and technology & game usage information. Moreover, the "learning environment preference

questionnaire" will collect information about the students' ideas of each specific learning environment. Finally, a posttest will be given to each group of students. The "posttest" is just a parallel form of the pretest which again includes 13 multiple choice questions and is an achievement test about "Mayer's principles of multimedia design". The development part and all the details of the tests and forms will be illustrated in the next chapters.

Moreover, the research model of the study is shown in Figure 3. In the model there are two independent and two dependent variables. The lines between the variables are in different colors and show different relations. The blue lines show the effect of computer literacy perception of students on their achievement level in each learning session environment. Similarly the red lines show the effect of computer literacy perception of students on their learning environment selection in each learning session environment. Moreover, the study is also trying to investigate the effect of each learning session environment on students' achievement level. Thus, the green lines show the effect of the learning session environments on students' achievement. Moreover the other 2 aims of the study are to compare students' achievement levels and their learning environment selections between the learning session environments. These two aims are shown with the orange lines.

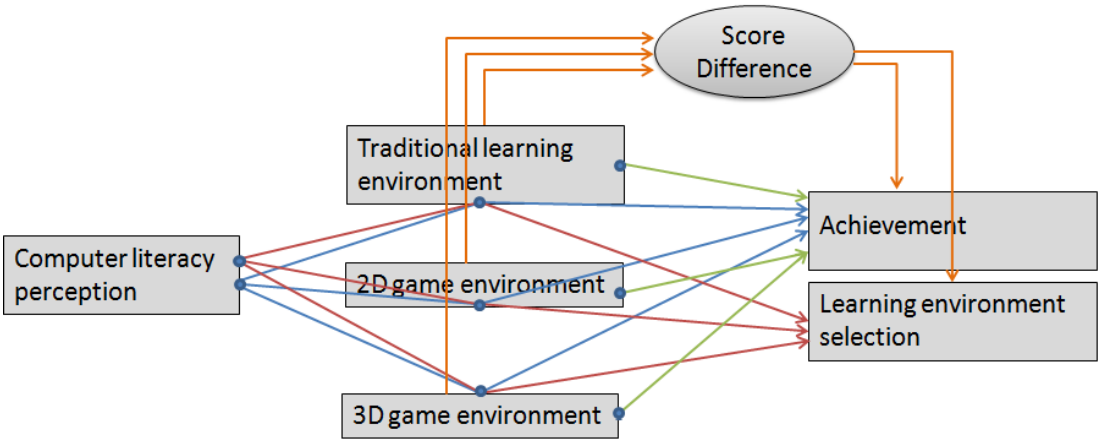


Figure 3. Research model

The study has been applied to the Boğaziçi University Faculty of Education students from 7 different departments who are taking the instructional technology lessons. The detailed information about the participants will be given in the following chapters.

Statement of the Hypotheses

In this study, there are 5 main research questions, and under each main question there are 3 sub questions, for a total of 15 sub questions. In accordance with each research question there is an alternative hypothesis. All the research questions and alternative hypotheses are shown in following chapters.

Research Questions

All of the research questions are given in this section. There will be a list of items that is preceded by the opening section of each research question.

When the learning unit of "Mayer's multimedia learning principles" is applied to the Faculty of Education students in the traditional learning environment, 2D and 3D game based learning environments;

1. Is there any meaningful relationship between students' perceived computer literacy level and their achievement?
    a. Is there any meaningful relationship between students' perceived computer literacy level and their achievement when the session is conducted in TLE?
    b. Is there any meaningful relationship between students' perceived computer literacy level and their achievement when the session is conducted in 2DGLE?

    c. Is there any meaningful relationship between students' perceived computer literacy level and their achievement when the session is conducted in 3DGLE?
2. Is there any meaningful relationship between students' perceived computer literacy level and their learning environment selection scores?
    a. Is there any meaningful relationship between students' perceived computer literacy level and their learning environment selection scores when the session is conducted in TLE?
    b. Is there any meaningful relationship between students' perceived computer literacy level and their learning environment selection scores when the session is conducted in 2DGLE?
    c. Is there any meaningful relationship between students' perceived computer literacy level and their learning environment selection scores when the session is conducted in 3DGLE?
3. Is there a significant difference between students' pretest and posttest scores?
    a. Is there a significant difference between students' pretest and posttest when the session is conducted in TLE?
    b. Is there a significant difference between students' pretest and posttest when the session is conducted in 2DGLE?
    c. Is there a significant difference between students' pretest and posttest when the session is conducted in 3DGLE?
4. Is there any significant difference between students' learning environment selection scores when the session is conducted in TLE, 2DGLE and 3DGLE?
    a. Is there any significant difference between learning environment selection scores of students whose session is conducted in TLE and the students whose session is conducted in 2DGLE?
    b. Is there any significant difference between learning environment selection scores of students whose session is conducted in TLE and the students whose session is conducted in 3DGLE?
    c. Is there any significant difference between learning environment selection scores of students whose session is conducted in 2DGLE and the students whose session is conducted in 3DGLE?
5. Is there any significant difference between students' achievements when the session is conducted in TLE, 2DGLE and 3DGLE?

a. Is there any significant difference between the achievements of the students whose session is conducted in TLE and the students whose session is conducted in 2DGLE?
b. Is there any significant difference between the achievements of the students whose session is conducted in TLE and the students whose session is conducted in 3DGLE?
c. Is there any significant difference between the achievements of the students whose session is conducted in 2DGLE and the students whose session is conducted in 3DGLE?

Hypotheses

All of the research hypotheses are given in this section. There will be a list of items that is preceded by the opening section of each research hypothesis.

When the learning unit of "Mayer's multimedia learning principles" is applied to the Faculty of Education students in the traditional learning environment, 2D and 3D game based learning environments;

1. There is a meaningful relationship between students' perceived computer literacy level and their achievement.
    a. There is a meaningful relationship between students' perceived computer literacy level and their achievement when the session is conducted in TLE.
    b. There is a meaningful relationship between students' perceived computer literacy level and their achievement when the session is conducted in 2DGLE.
    c. There is a meaningful relationship between students' perceived computer literacy level and their achievement when the session is conducted in 3DGLE.
2. There is a meaningful relationship between students' perceived computer literacy level and their learning environment selection scores.

a. There is a meaningful negative correlation between students' perceived computer literacy level and their learning environment selection scores when the session is conducted in TLE.
b. There is a meaningful positive correlation between students' perceived computer literacy level and their learning environment selection scores when the session is conducted in 2DGLE.
c. There is a meaningful positive correlation between students' perceived computer literacy level and their learning environment selection scores when the session is conducted in 3DGLE.

3. There is a significant difference between students' pretest and posttest scores.
    a. Students' posttest scores are significantly higher than their pretest scores when the session is conducted in TLE.
    b. Students' posttest scores are significantly higher than their pretest scores when the session is conducted in 2DGLE.
    c. Students' posttest scores are significantly higher than their pretest scores when the session is conducted in 3DGLE.
4. There is a significant difference between students' learning environment selection scores when the session is conducted in TLE, 2DGLE and 3DGLE.
    a. There is a significant difference between learning environment selection scores of students whose session is conducted in TLE and the students whose session is conducted in 2DGLE.
    b. There is a significant difference between learning environment selection scores of students whose session is conducted in TLE and the students whose session is conducted in 3DGLE.
    c. There is a significant difference between learning environment selection scores of students whose session is conducted in 2DGLE and the students whose session is conducted in 3DGLE.
5. There is a significant difference between students' achievements when the session is conducted in TLE, 2DGLE and 3DGLE?
    a. There is a significant difference between the achievements of the students whose session is conducted in TLE and the students whose session is conducted in 2DGLE.

b. There is a significant difference between the achievements of the students whose session is conducted in TLE and the students whose session is conducted in 3DGLE.
c. There is a significant difference between the achievements of the students whose session is conducted in 2DGLE and the students whose session is conducted in 3DGLE.

Definitions and Measurements of Variables

In the study, the independent variables are "learning session type" and "perceived computer literacy levels of students". Those independent variables can be defined as follows:

Learning session type: In the study, same learning unit is conducted in three different learning environments which are TLE, 2DGLE and 3DGLE. Learning session type identifies one of these 3 learning environments.

Perceived computer literacy level of students: The score taken from the "perceived computer literacy level" questionnaire which includes 10 items in 5 point Likert scale type. The scale identifies students' level of technology use which is included in the student information form and was created by the author. The form will be illustrated in following chapters in detail.

Moreover, for this study there are two dependent variables which are the "achievement of students" and the "learning environment selection scores of students". These dependent variables can be defined as follows:

The achievement of students: It implies the improvement of students learning in the specific learning unit. The achievement is calculated by subtracting the pretest score from the posttest score. Both of the achievement tests – pretest and posttest - are created according to the learning objectives in the specific learning unit by the

author. The details of these achievement tests will be given in the following chapters. As a formula the achievement is:

Student achievement = Students' posttest score – Students' pretest score

Learning environment selection score: It is the point taken from the "student preferences about learning type" questionnaire. The questionnaire includes 24 items in 5 points in the Likert scale form about the students' learning environment selection which consists of items created by the author, and the items which are adopted from another scale. The details of the scales are illustrated in the following chapters.

Subjects

The population of the study is the students in the 7 departments of the Boğaziçi University Faculty of Education. The seven departments are listed as: Guidance & Psychological Counseling, Integrated BS&MS Program in Teaching Mathematics, Undergraduate Program in Mathematics Education, Undergraduate Program in Science Education, Foreign Language Education, Integrated BS&MS Program in Teaching Physics, and the Integrated BS&MS Program in Teaching Chemistry. Although there are 9 programs in the Boğaziçi University Faculty of Education, 7 programs were chosen as the study area because the remaining 2 departments (Computer Education and Educational Technology (CET) and Preschool Education (PRED)) do not take the commonly taken instructional design course. CET students have more complicated instructional design courses and PRED students are preparing to study with pre-school students and as a result they do not have instructional design course in their curriculum.

The sample of the study are subjects from 60 Faculty of Education students who study in a public university - Boğaziçi University - in 2012-2013 education year in the fall term. The students did not take any instructional technology courses before, and they were taking an instructional technology course in the specified term in 4 different sections. The name of the instructional design course is 'Instructional Technologies & Materials Development' which is given by the Computer Education and Educational Technology department.

In the study 60 valid samples were divided into 3 groups which are 3 dimensional game based learning group (3DGLG), 2 dimensional game based learning group (2DGLG), and traditional learning groups (tradLG). In this categorization tradLG is the control; 2DGLG and 3DGLG are the experiment groups. Following statistics about participants of the study will be given according to this grouping.

Among all participants the majority of the students were both from the Guidance and Psychological Counseling (23 students) and Integrated BS&MS Program in Teaching Mathematics (15 students) and the distribution of the remaining departments were almost equal from other departments. Moreover, the students are in their 4^{th} to 16^{th} terms but majority of the students were either in their 5^{th} (24), 7^{th} (12) and 6^{th} (9) terms.

Table 4 shows descriptive statistics of student ages according to their groups. According to statistics average age of tradLG is 21.55 with a 1.10 standard deviation, 2DGLG is 22.29 with a standard deviation 1.88 and 3DGLG is 22.63 with a 1.54 standard deviation. According to these values, no significant difference exists among groups in terms of students' average ages.

Table 4. Ages of Students in Each Group

	Participant	Minimum	Maximum	Average	Std. Dev.
tradLG	20	20	24	21.55	1.10
2DGLG	21	21	28	22.29	1.88
3DGLG	19	20	26	22.63	1.38
Overall	60	20	28	22.15	1.54

In this part the creation of valid samples will be illustrated. The numbers of valid participants of the study for each group is given in Table 5. The number of valid samples in tradLG is 20. Although there are 45 registered students for tradLG sections (it consist of two sections), some of the students did not attend the lessons regularly. Although the teacher takes attendance for the classes, the participation was not stable. The applications are done in 3 different days for these two sections (pretest, application and posttest). In the pretest days there were 32 students in total and 6 of them did not want to participate in the study, thus the number decreased to 26. In the post test days there were 38 students but 2 students who attended to pretest were absent. The number then decreased to 24. Moreover in the application day there were 34 students but 4 students who attended both pretest and posttest were absent in the application day, thus the number of valid sample for the tradLG decreased to 20.

Table 5. Number of Registered Students and Students who Attend Different Parts of the Application

Group	Registered	Pretest	Application	Posttest	Left	Valid
TradLG	45	32	34	38	6	20
2DGLG	29	25	23	23	2	21
3DGLG	24	23	20	20	1	19

The number of valid students in 2DGLG was 21. Although there were 29 registered students to this groups' section, some of the students did not attend some part of the application. This application was completed in two different days and some students did not attend at least one of them. In this group the pretest was applied one day, and application with posttest and other forms was applied another day. In the pretest day, there were 25 students and 4 students were missing. In the posttest and the application day there were 23 students. One of the students in posttest wanted to leave the application because she was ill. Moreover all of the 22 students who attended the pretest also attended the posttest. Finally, one of the students was excluded from the study because he was cheating during the game. As a result, there were 21 valid samples in the 2DGLG.

The number of valid students in 3DGLG is 19. Although there were 24 students who were registered to the section of this group, some of the students did not attend either pretest or posttest day. In the pretest day 1 student was absent, there were 23 students. But in the second day in which posttest and application was done 4 students were missing, thus there were only 20 students. However one of the 20 students wanted to leave the study because he had to leave the class earlier. The students who did not attend the first day also did not attend to the other application day and there were only 19 valid students in the 3DGLG.

Finally Table 6 shows the gender distribution of the groups. It can be clearly seen that in all of the groups females were dominant because of general nature of the Faculty of Education. Percentages of males were 15% in tradLG, 23.8 in 2DGLG and 21.1 in 3DGLG.

Table 6. Gender Distribution Among Study Groups

	Participant	# Female	# Male	% of male	% of female
tradLG	20	17	3	15.0	85.0
2DGLG	21	16	5	23.8	76.2
3DGLG	19	15	4	21.1	78.9
Overall	60	48	12	20.0	80.0

As a result, although the groups are not perfectly homogenous, there are not statistically significant differences among group of students in terms of age and gender distribution.

Settings

In Boğaziçi University there are 2 academic terms throughout a year which are fall and spring, in each term there are 13-15 weeks lesson (depending on the yearly schedules). There is also a summer term but the course does not have to be opened in summer terms. The course is usually offered in both terms with 4-5 sections. The students from 7 programs of Faculty of Education students have to take the course in their 5^{th} to 9^{th} terms according to their curriculum. Each section usually accepts 20-30 students. The course has 4 course hours in a week and half of it is lecture and the other half is computer laboratory lesson.

In 2012-2013 fall term, 4 sections of the course were opened. 2 teachers and 2 research assistants were assigned to these sections. In this part, the formation of the groups with school settings will be illustrated. Firstly for the specified course in the specified term, the name of the 4 sections can be classified as section a, section b, section c, section d. Then two teachers can be called as teacher a and teacher b, and finally 2 assistants can be called as assistant a and assistant b for the sections. From these sections 3 research groups are created (tradLG, 3DGLG, 2DGLG). The distribution and student numbers under sections and their places in groups are shown in Table 7 as follows.

Table 7 Number of Students, Assigned Teachers and Assigned Assistants and Corresponding Groups for the Course

	# registered students	Assigned Teacher	Assigned Assistant	Group
Section a	29	Teacher a	Assistant a	TradLG
Section b	17	Teacher a	Assistant b	
Section c	24	Teacher b	Assistant b	3DGLG
Section d	29	Teacher b	Assistant a	2DGLG

For these sections, although the curriculums applied by teacher a and teacher b were different, the main contents of the sections were very similar. For both of the curriculums of the sections, "multimedia design principles" subject was one of the fundamental concepts. So all sections need multimedia principles content. In the specified term "Mayer's Principles of Multimedia Design" learning unit was included in all curriculums of the sections. Moreover, in the sections there were two different assistants; both of them were graduated from the same department, they were participating the courses as an equal level. Both of the teachers were assistant professors and both of the research assistants were master students in their theses year.

The control group which is tradLG consisted of section a and section b students who were taking the course from teacher a, and they were assisted by assistant a and assistant b. These two sections were merged as a one group because they took 2 hours (all sections have 4 hours in a week) of the course together. So these two sections formed the tradLG. The section c which was given by teacher b and assisted by assistant b was chosen as 3DGLG. And finally the section d which was given by teacher b and assisted by assistant a was chosen as 2DGLG.

In study weeks, the application was done in both classroom and laboratory environments. Table 8 shows the venues of the application.

Table 8. The Venues of the Applications

	Pretest	Application & forms	Posttest
tradLG	Laboratory 1	Classroom 1	Laboratory 1
2DGLG	Laboratory 1	Laboratory 1	
3DGLG	Laboratory 1	Laboratory 1	

In the tradLG the study was applied in 3 days for both of the sections. Pretest and posttest were done in laboratory environments. Because it was a paper based test, the laboratory environment was not considered to have a negative effect. The application was done in classroom environment which was a classical class environment with a board and projection screen.

For the 2DGLG and 3DGLG same learning settings were used. For both of the groups, the applications were done 2 different days. In the first days, the pretests were done in laboratory settings. Then in second days the applications were done in the same laboratory environment.

Developments of Games

For the research, 3 quiz games and an administration platform are developed by the author. The first game is called as "Risk Elimination Game". This game is developed in Adobe Flash environment and it includes some questions about the learning content with some animations. The game is used in both game groups as a game elimination part and it is an individually played game. It serves as an elimination game because in each game group, participants need to achieve a specific goal which is to take 1200 points over 1500 points in order to start risk games. Moreover, the second game is "2D Risk Game". Risk game is a multiuser competition game which is played in many television programs. The game is developed in Adobe Flash environment and it is a 2D multiplayer online game. Only 2DGLG is playing this game. In this part, users try to get more points than their competitors by writing the correct question about given answers. So the given answers in the game serve as questions and the response questions which are provided by the students serve as

answers. The aim of the game is to become one of the top three students at the end of the game. Finally the third game is "3D Risk Game" which has the same rules with the second game but this time users will play in a 3D multiplayer online game environment. This time only 3DGLG participants will play this game. The game is developed in Avaya Engage environment by combination of some other technologies. In brief, the Table 9 shows the main specifications of the three games.

Table 9. Main Characteristics of 3 Games

	Group Played	Goal	Game environment
Risk Elimination Game	2DGLG 3DGLG	To get more than 1200 points over 1500 points by answering 15 multiple choice questions	2D single player flash game
2D Risk Game	2DGLG	Becoming one of the top three students at the end of the game by writing correct questions for the given 10 answers.	2D multiplayer flash game
3D Risk Game	3DGLG	Becoming one of the top three students at the end of the game by writing correct questions for the given 10 answers.	3D multiplayer online game in web.alive environment

Moreover, there is an administration panel which is also developed in Adobe Flash environment. Thanks to this panel teacher can manage the games and evaluate the questions given by students in the 2D and 3D games quickly in real time.

The specifications and preparation details of each of the tools are identified in the following part.

Risk Elimination Game

Risk elimination game is a 2D single user flash game as it is mentioned before. The aim of the game is to answer 15 multi choice questions correctly. Each question includes an animation, and the question is about the animation. Students need to play the animation before answering the question. With the animations students will learn the content so the game includes teaching functions rather than just being quiz games. The animations are about Mayer's Multimedia Learning Principles which is the learning task. The Figure 4 shows the main game screen.

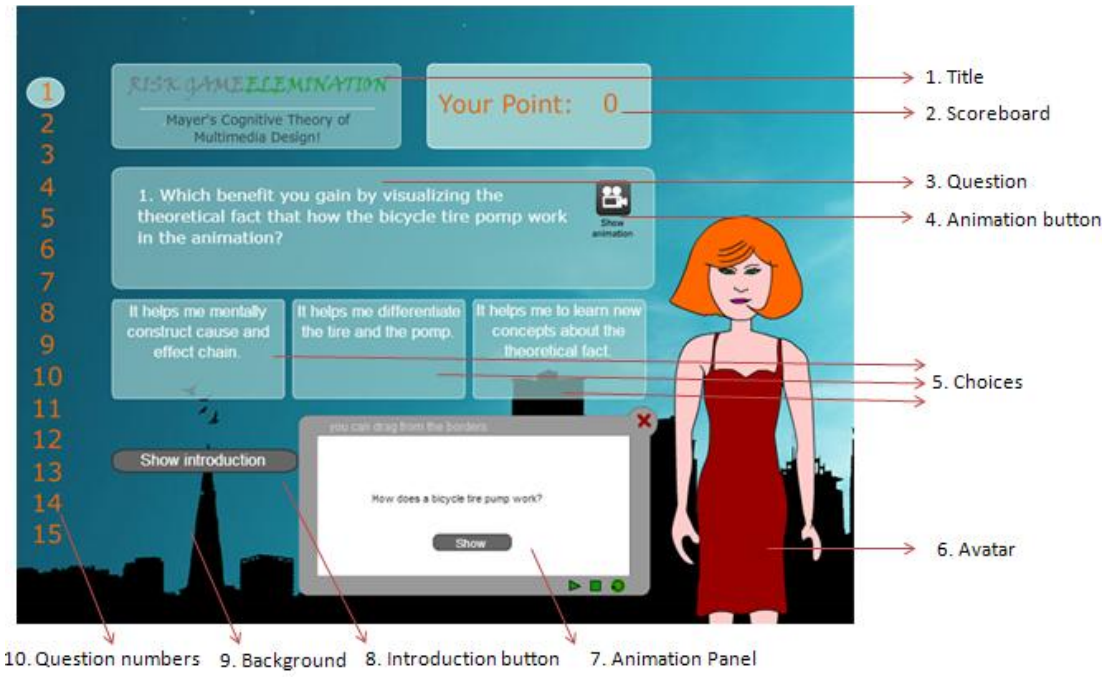


Figure 4. Main screen of the 'Risk Elimination' game

In the screen, the parts are shown with numbers. Number 1 shows the title of the game which is shown throughout the game. Number 2 shows the scoreboard, when a player answers current question, s/he gets 100 points from this game. Each question has the equal points, so any player can get 1500 points at most. If the player selects the correct choice in his/her second trial than s/he gets 50 points in this question, if the player finds the correct answer in his/her third trial, s/he gets 0 points because

there are only 3 options for each game. The current score is shown in this panel for the game by number 2 (in the example picture it is 0). Then, number 3 shows the root, number 5 shows the choices of the current question. The animation of the current question can be opened with the button shown in number 4. When the player clicks this button, the animation panel will be opened which is shown in number 7. In this panel the animation can be played, stopped and replayed by the buttons at the bottom right of this panel. Also this panel can be moved in any part of the screen by mobility feature of the mouse and it can be hidden by clicking the cross button in the top right screen. In some animations the animation itself has some control buttons just like in the example figure. In the example player needs to click the "show" button inside the animation to continue to view the animation. Moreover number 6 shows the avatar which serves as the talent of the game. She explains rules of the games at the beginning of the game or when the player clicks the show introduction button which is shown with number 8. Number 9 shows the background which does not have any contribution to the game, it only shows the environment. Finally number 10 shows the question numbers and the current state of the game, with the circle over the number.

When a user answers a question by clicking on the answer buttons, s/he can receive 2 responses. If the answer is wrong, game gives error sound and the color of the selected answer is turns into red (Figure 5).

Figure 5. Wrong answer

If the player clicks on the correct answer (for the current question in Figure 5, it is first selection) the selection turns to green, the student hears the sound of "correct" answer and a popup screen is shown which says "You gain x points in the question" and "Your point: Y" (Figure 6).

Finally, in this screen there is a "next question" button. In this screen user cannot click on any other button in the screen except this button. It is because after the completion of the question, the student needs to continue with the following question. When the user clicks on this button, the game continues with the next question. Next question includes a new content with a new animation.

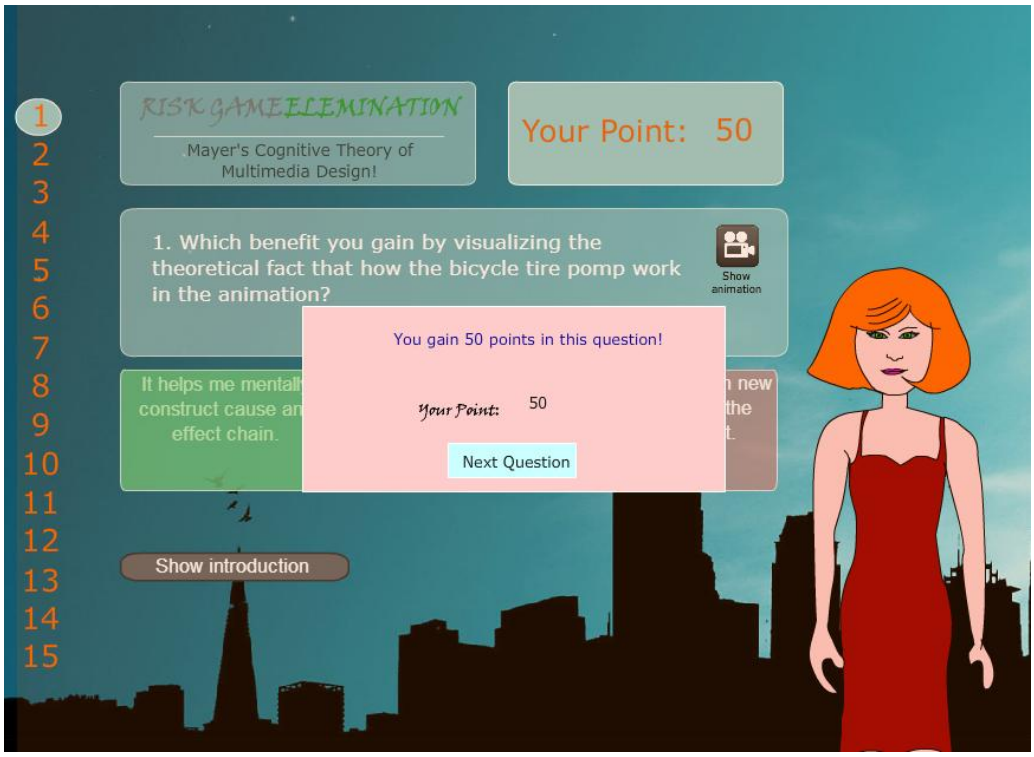


Figure 6. Correct answer

Just like the question explained the game continues with 15 similar questions with the same logic. At the end of question 15, students can see two different screens; if students get more than 1200 points s/he sees a congratulations screen (Figure 7) which means user completed the game successfully, if they get less than 1200 points they sees a sorry screen (Figure 8) which means that user failed the game and needed to restart the game.

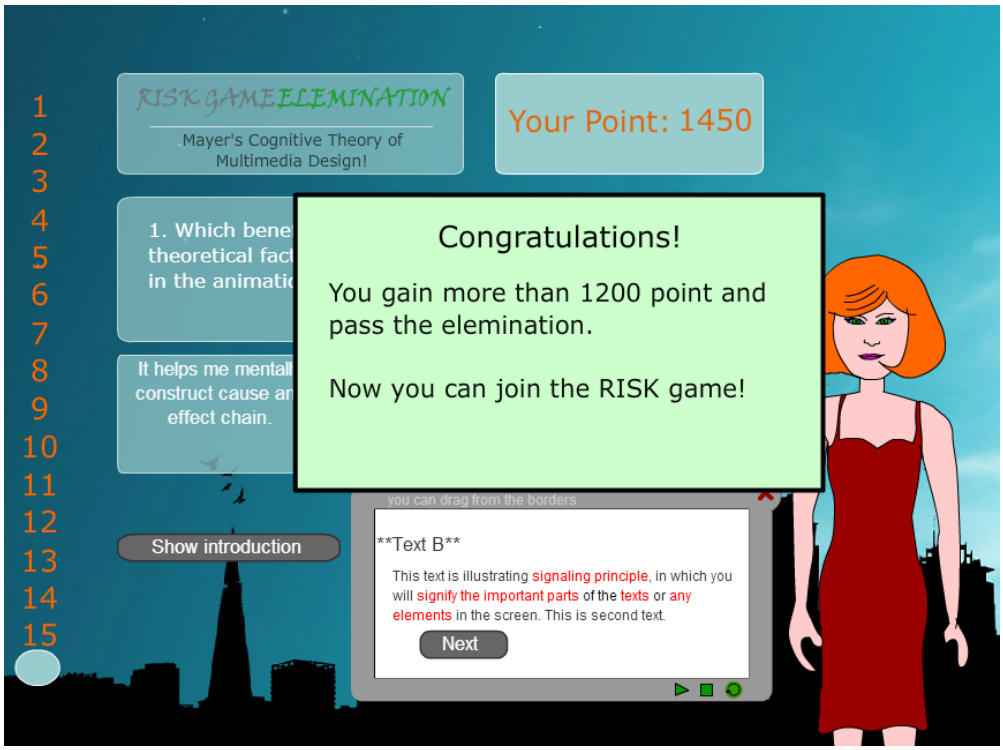


Figure 7. Pass screen

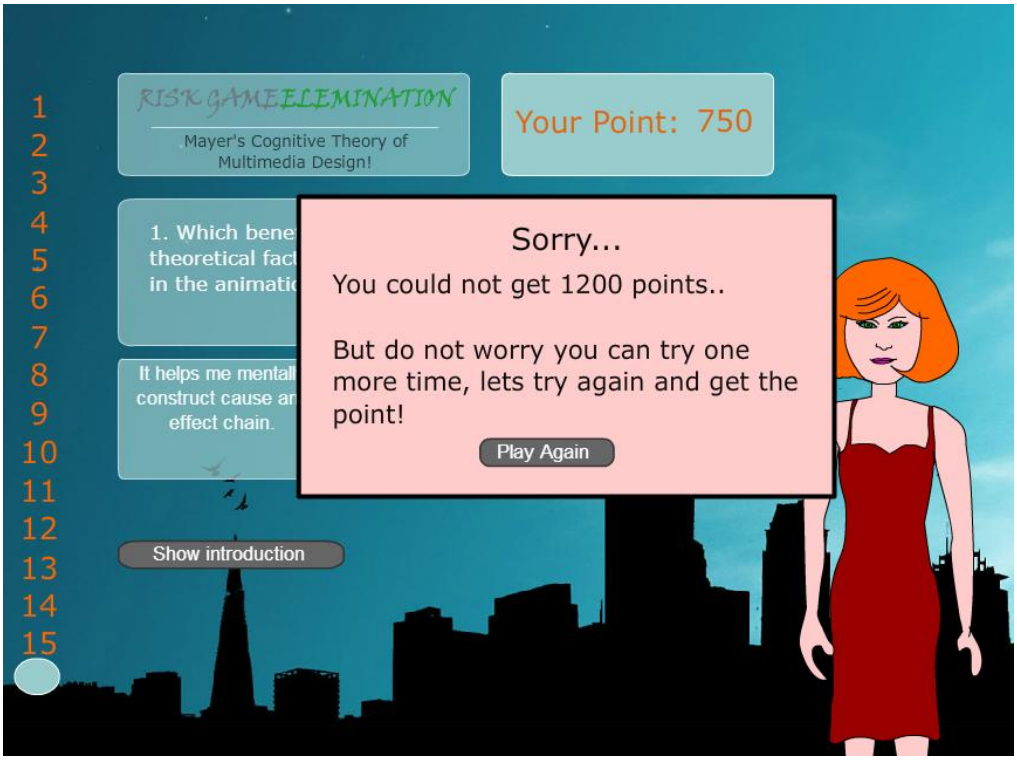


Figure 8. Fail screen

Another important part of the game is its introduction part. In the introduction part, the avatar tells the rules of the games in a few screens. In the first screen, she introduces the game (Figure 9).

Figure 9. Introduction part 1

Then, in the next introduction screen the avatar tells the aim of the game, and the point of the game is shown (Figure 10).

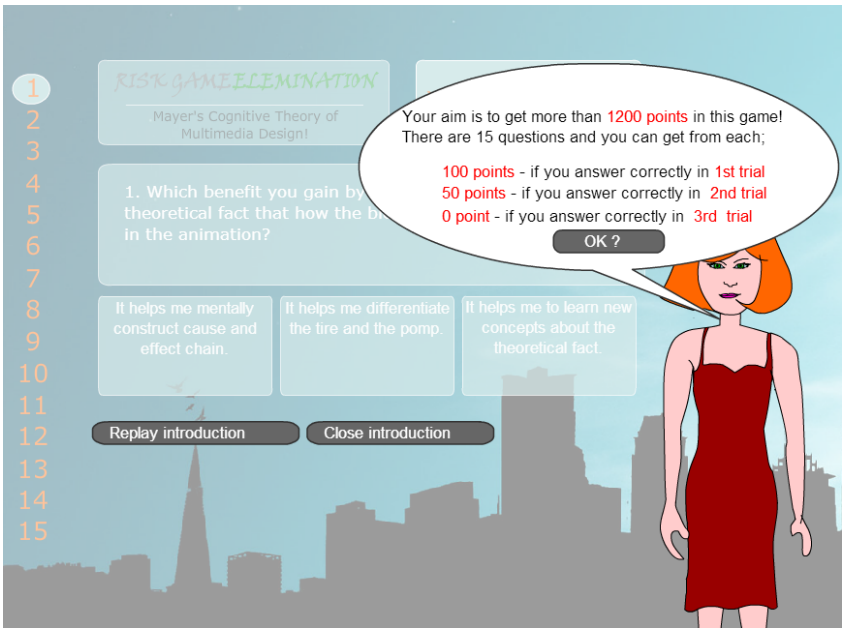


Figure 10. Introduction part 2, goal

Then, the buttons and parts in the game are introduced to the player. Figure 11 shows the animation button, selection buttons and points part of the game to the student.

Figure 11. Introduction 3 – Button definitions

Finally Figure 12 shows the final part of the game in which avatar says “good luck!” and the introduction part ends automatically.

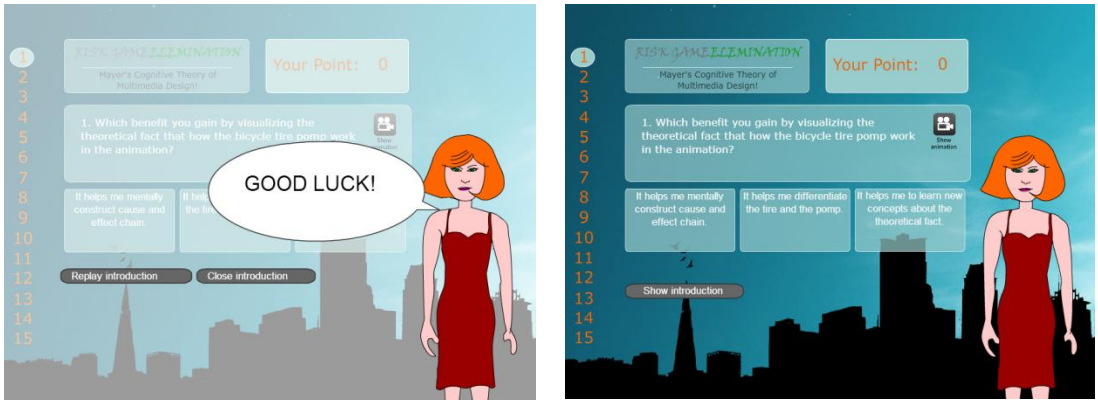


Figure 12. Good luck and start of the game screens

During the introduction part, there are two buttons on the bottom left side of the screen which are “replay introduction” and “close introduction” buttons. When the user clicks on “close introduction” button, the introduction part is closed and instead of these two buttons, “show introduction” button appears.

Finally the screen contents of the 15 questions and answers are shown in the appendix A.

Two Dimensional Risk Game

Risk game is a commonly played television game. The game is played between more than one players as a competition game. The core concept of the game is to find the correct questions for any given answer. For example; the game says that “The planet that we are living” as an answer. For that answer players try to ask the correct question. In that case player should ask the correct question as “What is world?” So in the game the given "answers" by the game serve as "questions" and the "questions" provided by the students will serve as "answers", in the following parts the terms will be used in such order.

The game consists of this type of questions. The questions in the game belong to categories. For example, the example question in our case belongs to the category of “Planets”. In each category there is more than one question which has different points. While the first question in the "Planets" category has 100 points, the second question of the same category has 200 points. Figure 13 shows the example screen of the game categories and corresponding points. In the example the categories are ‘multimedia’, ‘theory’ and ‘principles’. Each category in the example has 3 questions which have 100, 300 and 500 points.

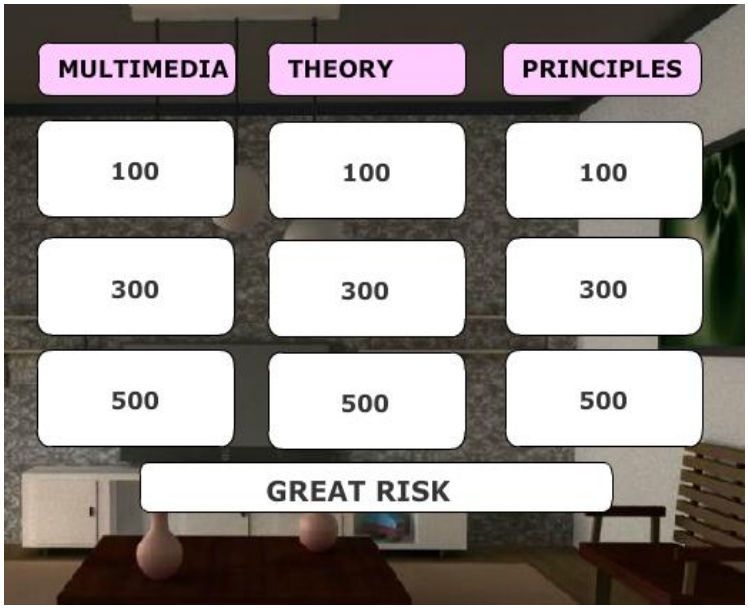


Figure 13. Category and points screen

When a player answers the “Multimedia 100” point item, s/he can get 100 points. However if s/he answers incorrectly/wrongly, s/he will lose 100 points. If s/he does not provide any answer s/he will neither gain nor lose any point.

In this part lecture version of the game will be discussed. The rules of the lecture game are just parallel to the original game but there are some differences for the school settings. Generally this game is played as a small group of people but in our case it will be played by the whole class. There are about 20 students in the class and they all play together. So in the original game, only one player has a right to answer a question at a time but in our game all players should answer all the questions independently. In the original game players provide answers verbally but in this version students will write the answer from their game screens. In Figure 14 the main screen of the game is shown with its’ components.

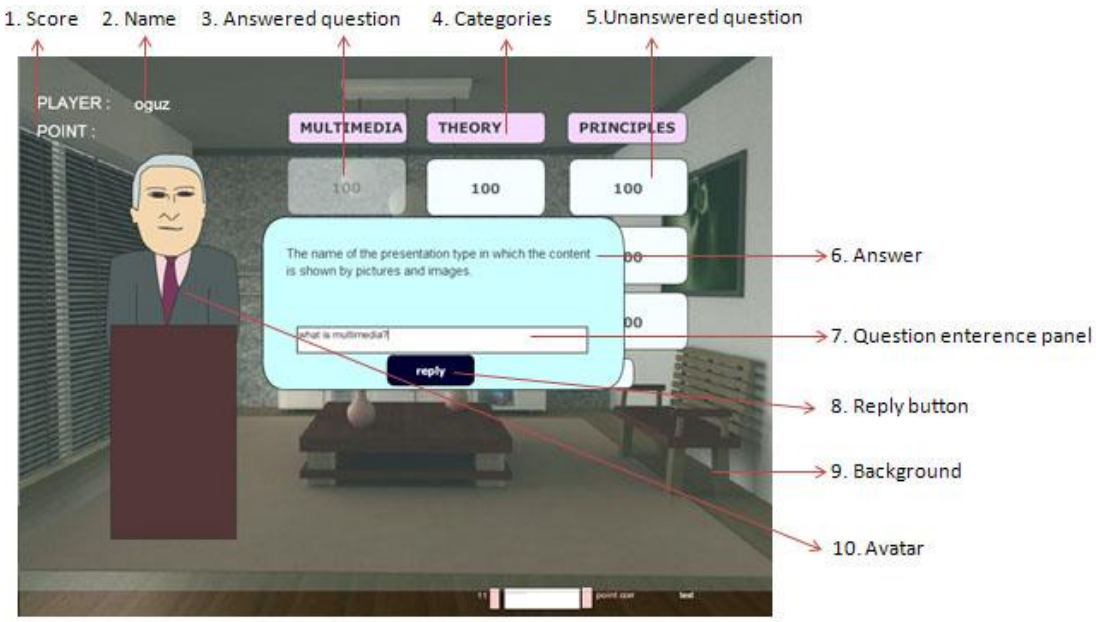


Figure 14. Main screen of 2D risk game

In the screen, number 4 shows the category name. Number 3 shows an answered question which have a value of 100 points and it is a multimedia category question. The numbers over the squares show the points of questions, the columns of the questions show the categories. Moreover, number 5 shows an unanswered question. The difference between the answered and unanswered is the transparency of the question, in the game answered questions are more transparent. A player can click on an unanswered question and the content of the question will appear in the panel shown in the middle. In this panel there are 3 items; number 6 shows the current question, number 7 shows the answer entrance part and number 8 shows the "reply button" which serves as to complete answering action. Moreover, number 9 shows the background which only serves as an environment, number 10 shows the avatar which serves as a presenter of the game and does not have any other function. Number 2 shows the name of the player, and finally number 1 shows the current score of the player.

Moreover, when the game is started, students need to know the rules of the game. In order to give the rules to the students and taking the name of the students; an introduction screen is used (Figure 15).

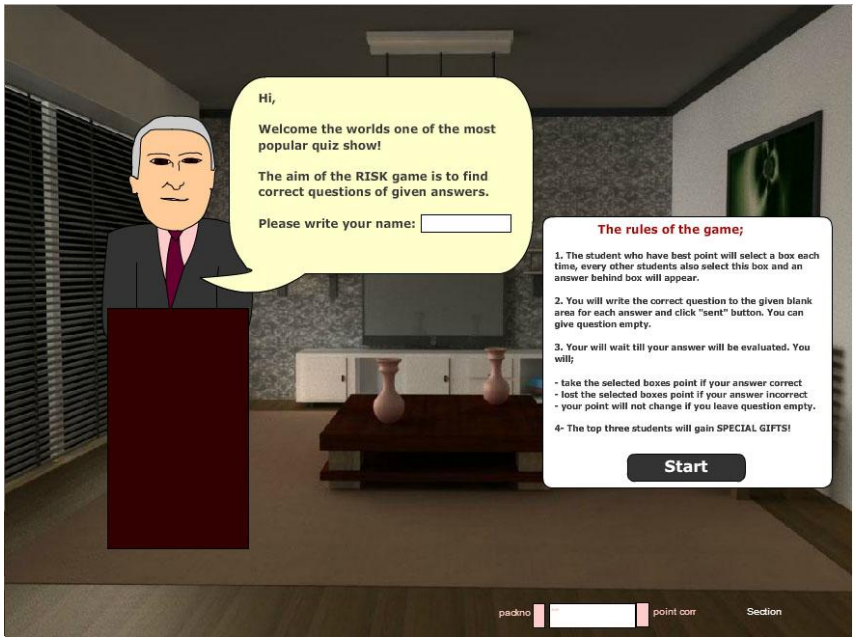


Figure 15. The introduction part of the 2D risk game

In this screen student can read the introduction text which is given by the avatar and write his/her name to the empty textbox. Then, after reading the rules of the game s/he can start the game by clicking on the start button.

The game will start with the multimedia 100 points and each player will answer the question which shown in Figure 16.

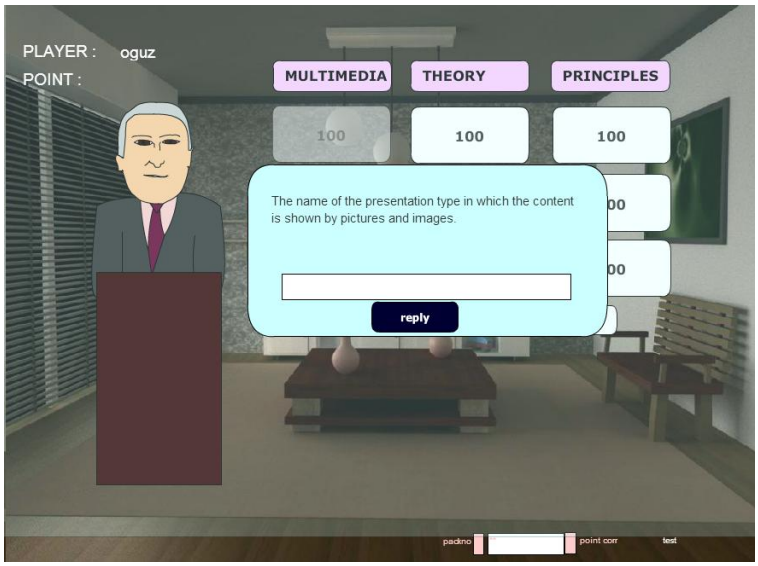


Figure 16. Question 1

In this question after each student clicks on the reply button, all students see a "waiting for response" screen which is shown in Figure 17.

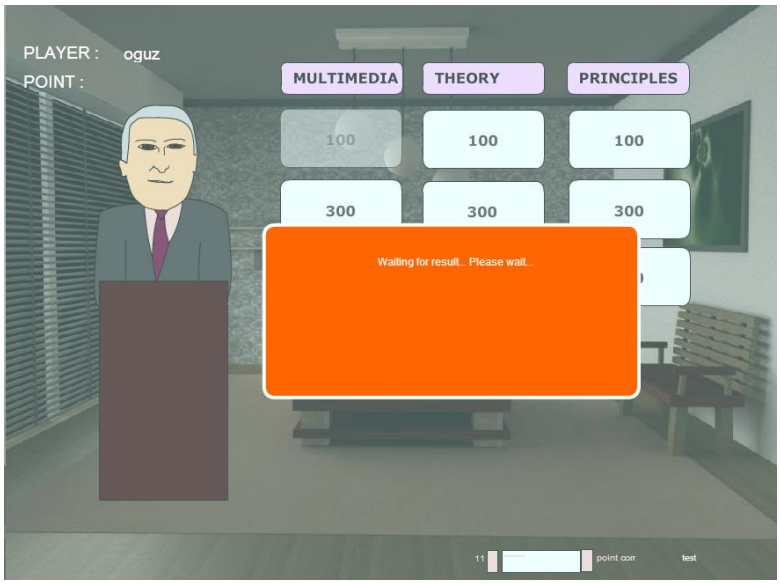


Figure 17. Waiting for response

In this part, the teacher views all the replies of students in admin screen and marks them as "correct", "incorrect" and "empty" as shown in Figure 18.

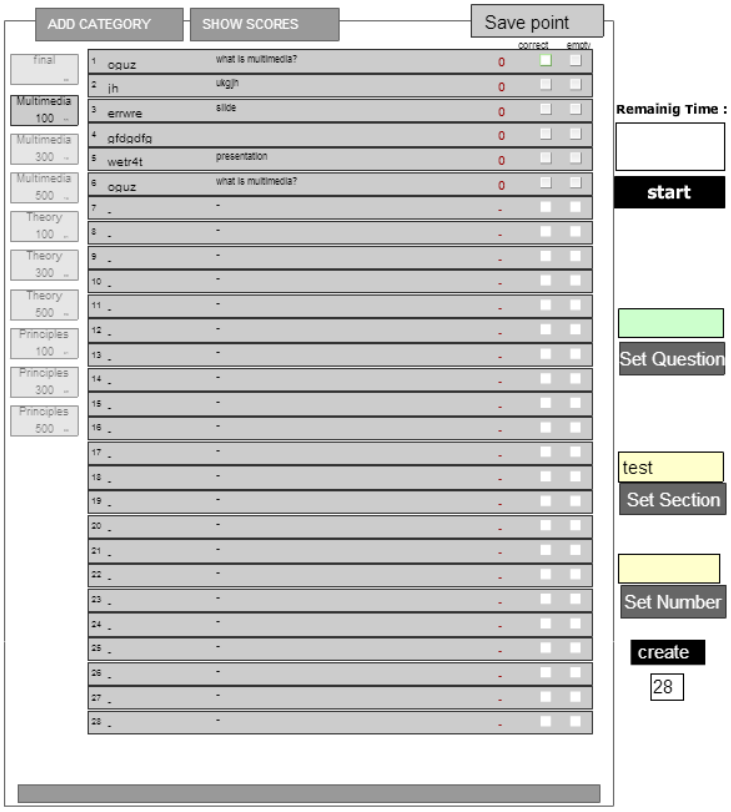


Figure 18. Question replying in admin panel

In the admin panel there are many controls related to game parameters but in this part the issue is grading the answers of the students. Teacher can click on the question buttons on the left side, in that part there are square buttons for each question. For example, to see the replies of the “multimedia 100” question, teacher needs to click "multimedia 100" button. When the teacher clicks on this button, the questions coming from the students are shown in the middle part with numbers. In that part students are listed from highest point to the lowest point. For each answer there are two check boxes on the right side which are “correct” and “empty”. Teacher will check the correct box if the answer is correct, s/he will check the empty box if the answer is empty and s/he does not check any of the two boxes if the answer is incorrect. After checking all the answers the teacher will click on the “save point” button in the top part and then responses are sent to all students.

When the replies are sent to the students, they can see three response screens automatically. As it is mentioned in Figure 18, the students see the “waiting for answer screen” until the teacher sends the responses. If the student answers correctly then s/he will get the "correct" reply which is shown in Figure 19. In that case student takes the points of question. If s/he answers incorrectly, she will get the "wrong" reply which is shown in Figure 20. In that case the student loses the point of the question. Finally if s/he leaves the answer empty then s/he will take "empty" reply which is in Figure 21 and his/her point does not change.

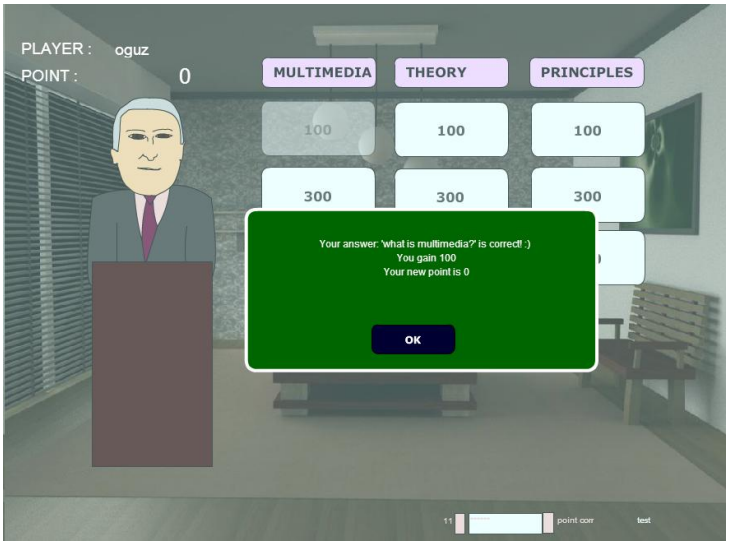


Figure 19. Correct answer screen

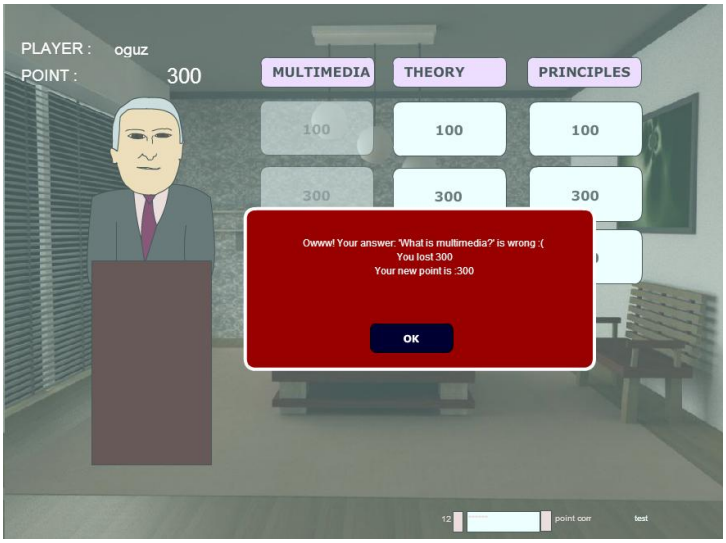


Figure 20. Incorrect answer screen

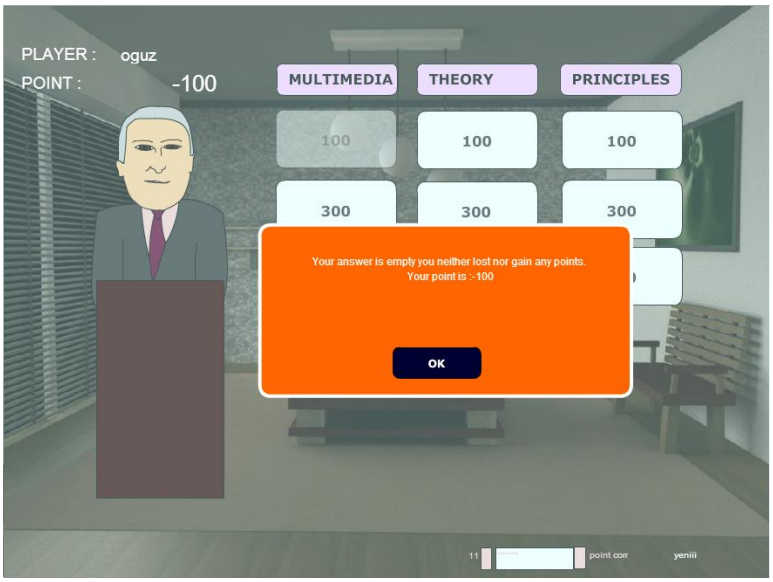


Figure 21. Empty answer screen

In the game there are total of 9 questions in the form that is presented in this section. The logic of the answering and grading are the same with the example question. These question screens are shown in appendix B.

After completing these parts, each student will have a point. During these parts at the end of each question students will see the whole points of the class and their rank. They try to get a better place after each question because the rank is shown according to students' points. After completing the game, students will play the risk part. The risk part is the final placement of the game. If any student completes the game with less than 500 points, s/he can risk 500 points. If any student completes the game with a positive score s/he can risk his/her all points at most. For example if a student completes the game with 1000 points, s/he can risk 1000 points or less than 1000 points. After they choose the riskeamounts they will see the question. The risk screen is shown in Figure 22 and the risk question is shown in Figure 23.

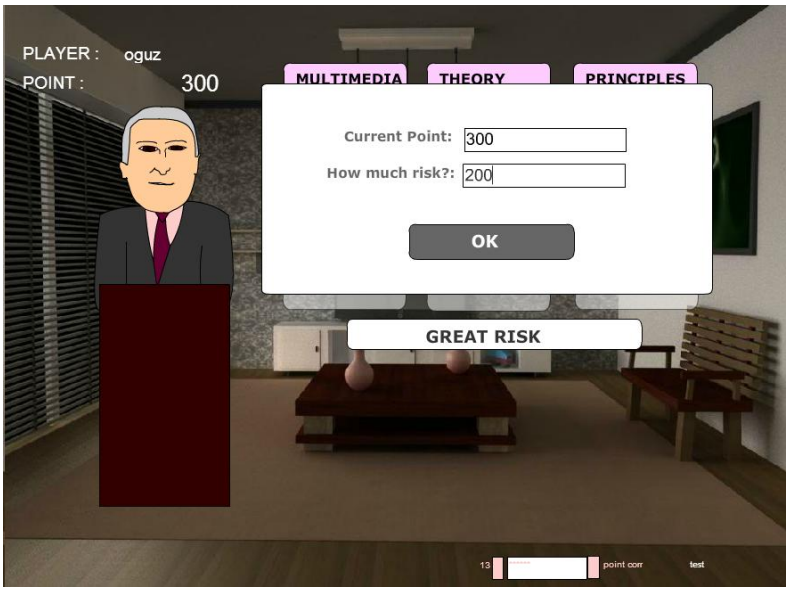


Figure 22. Selecting risk amount

Figure 23. Risk question

When the students give response to the risk question, the response and giving points will be done just like the previous questions, only difference is the selection of risk amounts. If their answer is correct, they win the risked amount of points; if their answer is incorrect or they leave the question empty, they will lose the points that they risked.

After grading this part the final rank of the students are determined. First three students win the game and they get awards (in our research they get chocolate).

Three Dimensional Risk Game

The third game is 3D risk game. This game has the same rules with the 2D risk game but this time the environment is 3D. The 3D environment is designed in Avaya web.alive environment which is a 3D multiplayer online game development environment. In this platform a 3D competition game studio is created. In the studio there is a square place in the middle for the players of the game. In the square place there are desks with computers for each player and a desk for the presenter. Around this place, there are many fake visitors which are watching the game. So the environment is just like a competition game on the screen. Each student can walk around this environment. Figure 24 shows this environment.

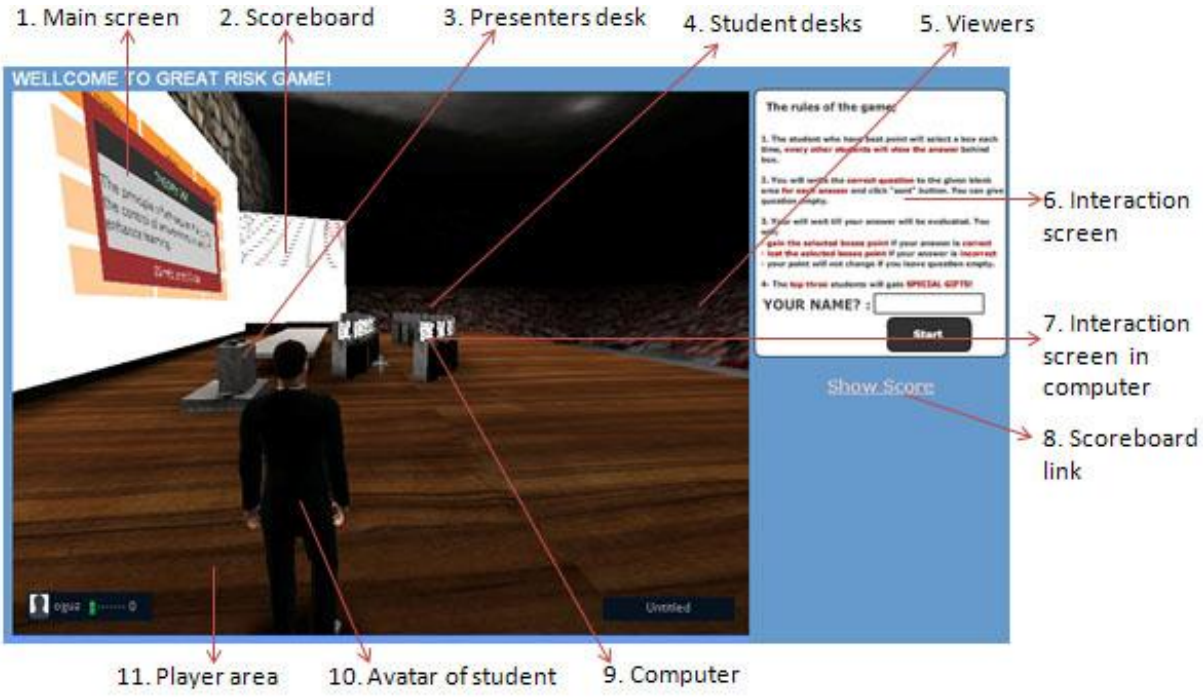


Figure 24. Three dimensional game environment

As it is shown in the Figure 24, in the 3D environment there are 2 screens; main screen is shown with number 1 and scoreboard is shown with number 2. All players will stay in front of the student desks which are shown with number 4. All can see both main screen and scoreboard screen. Also, on these desks there are computers which are shown by number 9. In the main screen, the content of the questions will be shown. Each student can enter their answers with 2 interaction screens. The first one is shown by number 6 and the second interaction screen which has the same content with the number 6 is shown by number 7. Students can enter their answers with any of these two screens. Student can see all players' points from the scoreboard screen with number 2 or they can see the scores on a webpage by clicking on "show more" button by the number 8. Number 3 shows the presenter's desk in which the presenter can direct the competition by clicking on the buttons on the desk like displaying a question on the screen. Moreover the student can see his/her avatar which is shown with number 10. Finally number 5 shows the viewers in the environment and number 11 shows the player area in which players play the game.

When the game starts, the main dynamics of the game environment are illustrated to the students verbally by the facilitator. In detail, any student can move his/her avatar by a, w, s and d keys on the keyboard for different directions, they can change the view by using mouse mobility, they can enter any information to the panel in the right side and they can open a very similar screen which has the same functions with the other panel by clicking on the computer screens which is shown in Figure 25.

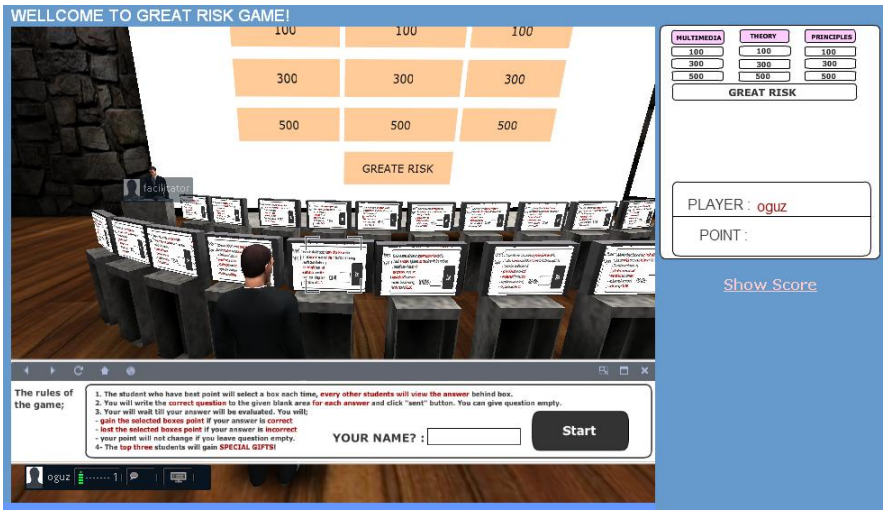


Figure 25. Interaction screens

Then, during the game players can use the interaction screens just like in the 2D risk game. In Figure 25, users can write an answer on the right panel like the computer screen panel. In this part, is should be mentioned that the answer part in the interaction panel comes automatically when the presenter chooses a new question. In this way all of the players can play at the same time. Figure 26 shows the answer entrance part.

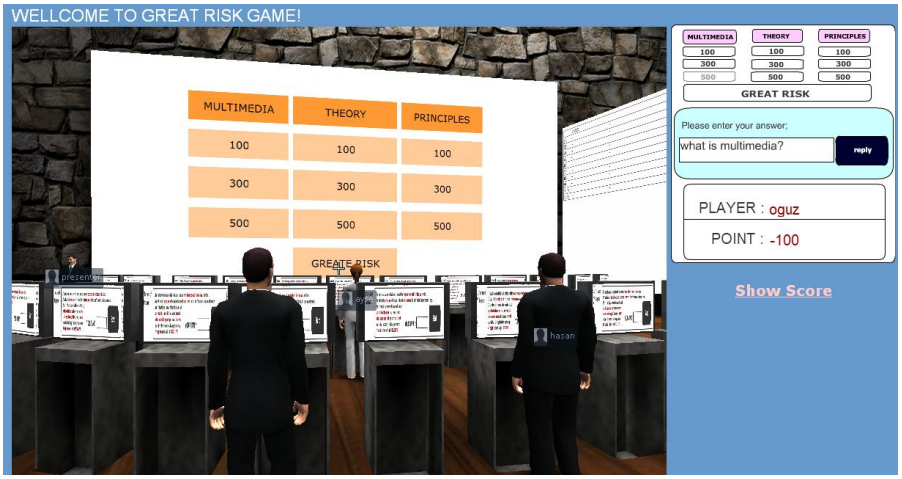


Figure 26. Question entrance screen

After entering the answer, a student can see the “waiting for response” part. In this part the teacher marks all of the questions as “correct”, “incorrect” or “empty” in the

same screen with the 2D risk game which is shown in Figure 18. The “correct”, “incorrect” and “empty” responses are shown in Figure 27.

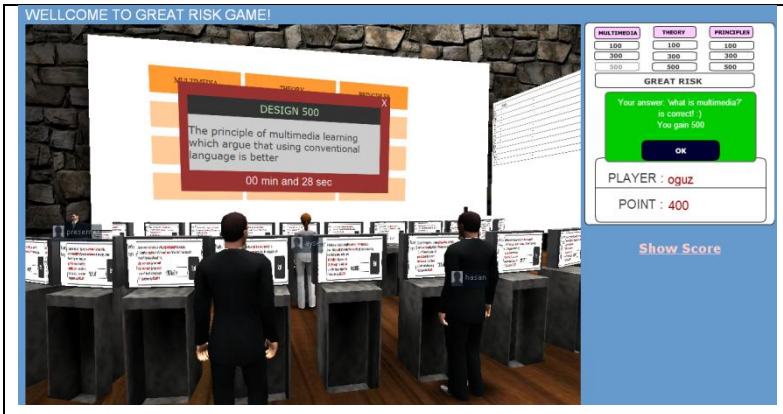
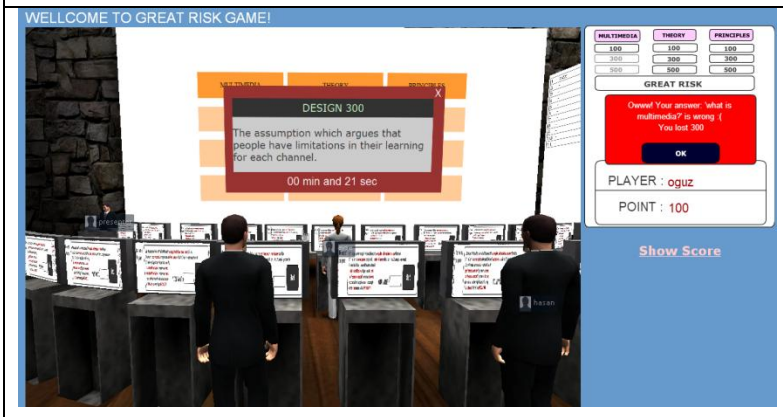
	a) Correct response
	b) Incorrect response
	c) Empty response

Figure 27. Responses of the game

At the end of each question, students' points can be seen on the scoreboard on the left screen or using the “show score” button. In that screen again the order of the students will be arranged according to their points, the student who has the highest point will be shown as the 1st rank in the list.

The nine questions in the game will be played like the first question and at the end of this period they will play the risk part. The nine questions are shown in Appendix C.

After playing these parts students will have some points and they will play the final section which is risk part. Again in this part students can risk up to 500 points if they have less than 500 points, if they have more points they can risk up to their total points. The risk question is shown in Figure 28.

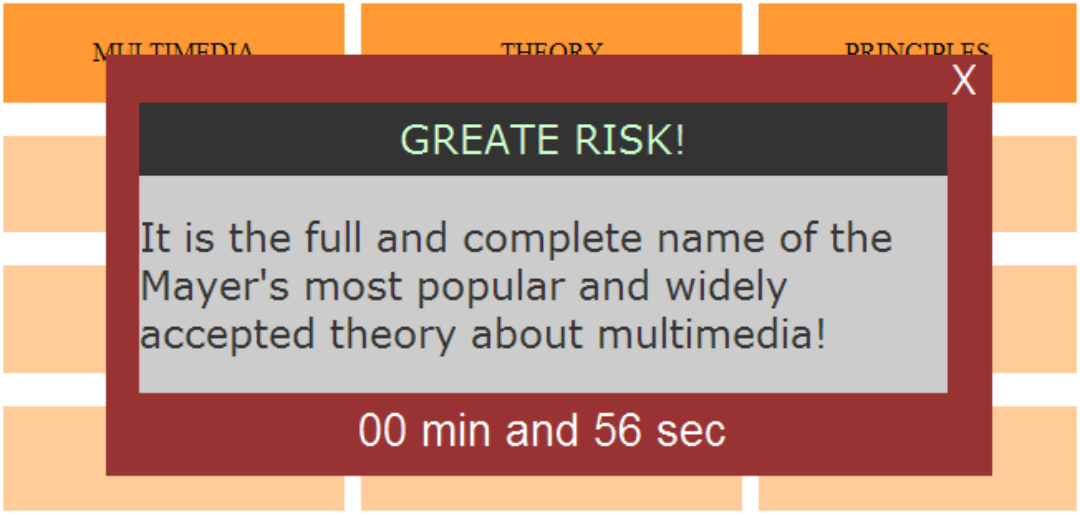


Figure 28. Risk question

As it can clearly be seen, the 3D risk game is just the 3D version of the 2D game. At the end of the game first 3 players in the game win the game and get a gift (in our case it is chocolate).

Game Administration and Structures

Finally there is an administration part in which the teacher can control the competition games in 2D and 3D platforms. This platform is developed in Adobe Flash environment. Actually when it is said that the platform is developed in a specific environment, it is referred to the interface of the game. There is more

complicated structure of games that uses different technologies. In this part the functions of the game interface and the structure of all games will be illustrated.

Firstly, Figure 29 shows the introduction part of the administration panel. In this screen there is only a password box and an entrance button. The administrator of the game can enter the correct password and enter the environment.

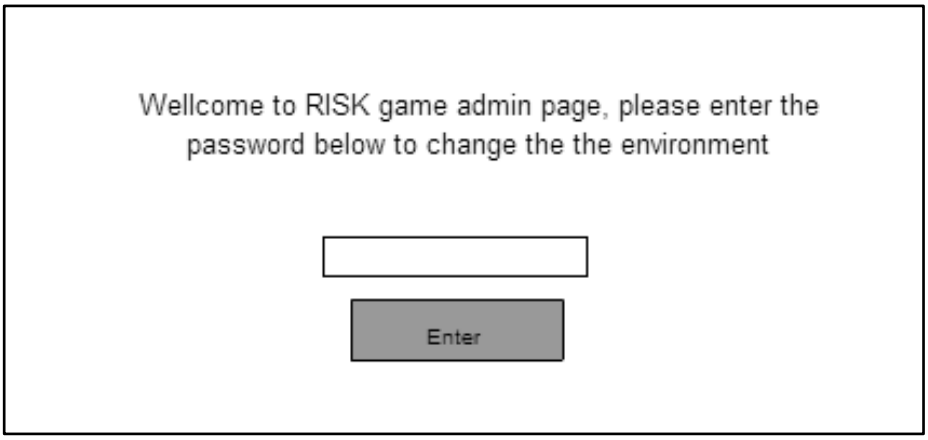


Figure 29. Administration entrance screen

In the administration entrance part, no username or user registration is wanted because this game is used by only the teacher in the game. If it needs to be used by more than one teacher, these part needs to be modified.

Moreover the main screen of the administration panel is shown in Figure 30. In this screen all administration of the game can be done.

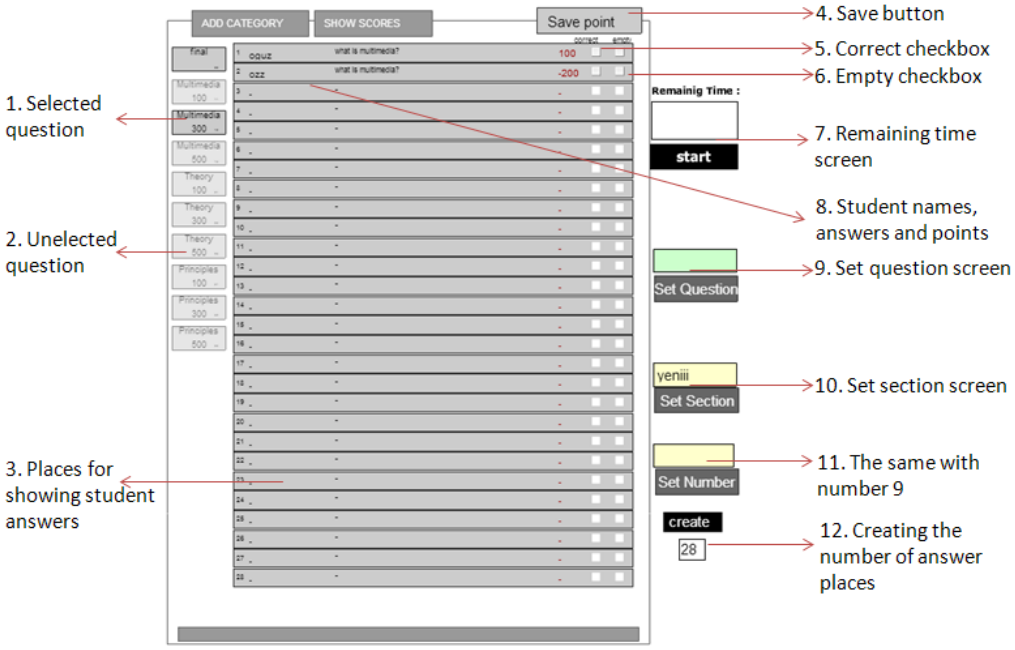


Figure 30. Administration panel

In the administration panel, number 1 and number 2 show the question selection buttons. The selected question which is number 1 is shown a little darker than other buttons and when the button is selected, the questions of students which are given for this item are shown in the middle part which has 28 places. Each of these places is single lines which are shown by number 3. The maximum number of items can be changed by entering the required number to the text area and by clicking the "create" button which is shown in number 12. Moreover the answers of the responded students for the selected question are listed in these places as shown in number 8. In these places each students' name (or nickname), their given answers for the selected question and their current points up to this question are shown. In this part, the ordering of the students is done according to their current points. Student who has the top point will be shown on top of the list. The teacher can mark all the questions as "correct" or "empty" by using "correct" and "empty" check boxes which are shown with number 5 and number 6. In this part if teacher does not check any of the two

check boxes it means that the answer is "incorrect". When teacher completes to mark the answers, s/he will need to click on the "save point" button which is shown by number 4. After that a new question procedure is started. Teacher can show this administration panel with the projection device and thus both group of students can see the marking procedures and their order. Moreover, the time limit for each question is shown in this panel. The remaining time can be seen by number 7. Then, there are 2 more administration places in the game which are "setting section" and "setting current question". "Setting section" means starting a new game. The students' responses are recorded to the system according to a section name which is shown by number 10. It means a new game with a new section is started, teacher should write a new section name to the box and click on to the "set section" button. Finally, the "set question part" is for the 3D risk game which is shown by number 9 and 11. As it is illustrated before, the question entrance part in the 3D game is displayed automatically without user selection. To show any question in 3D game control screen, teacher should write the code of the question to the box and click on the set question button in this place.

As a result, teacher can grade the students' answers, change section information, change question information, show student orders and remaining time control by using administration screen.

In this part of the structure of the games, communications and corresponding technologies will be illustrated. The 2D elimination game is simply designed in Adobe Flash environment by using Action Script 2 codes. It is put to a web folder, and can be viewed by any web browser with internet connection. In the study the game is published at www.oguzak.net web address and "Google Chrome" is used as a web browser.

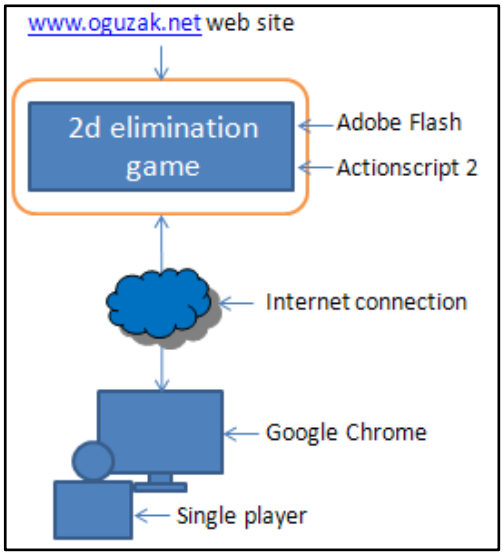


Figure 31. 2D elimination game structure

As it is shown in Figure 31, the game is on the website and a single player can play the game via internet and internet connection.

In the 2D quiz game there is a more complicated structure. Because this time student response data and corresponding teacher answers should record in a database and the game platforms should communicate with each other. The complete 2D risk game model is shown in Figure 32.

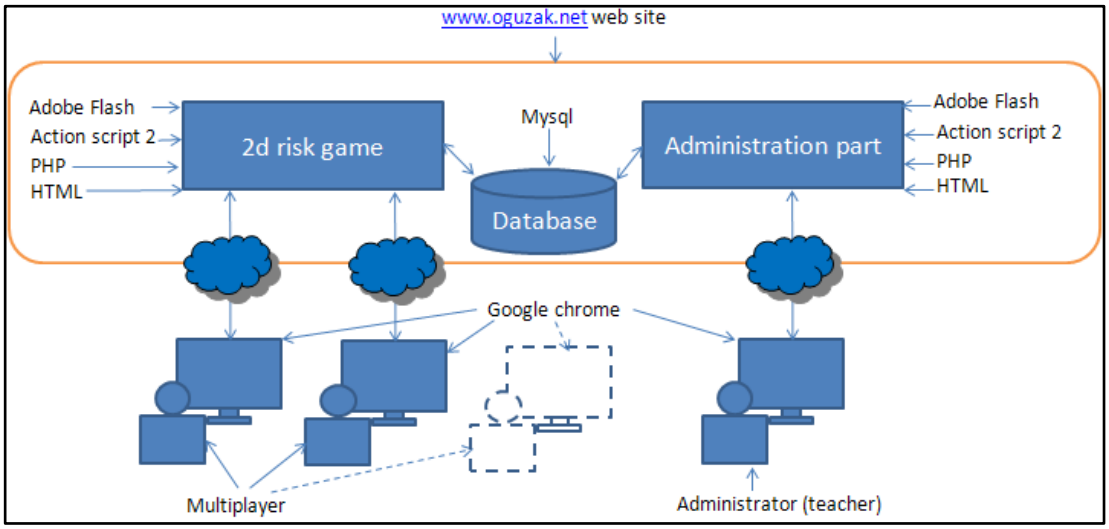


Figure 32. Two dimensional risk game structure

In the game there are many users who display the game on their computer via Google Chrome. The 2D risk game and the administration part are created by Adobe Flash platform with Action Script 2 codes. After interfaces and internal dynamics of the platforms are created in Adobe Flash, they need to communicate with each other via a database connection. As a database, MySQL technology is used. Each answer comes from the users and the corresponding grading by the teacher is written to the database. In order to send user information to the database a dynamic language code was is required and to complete this action PHP codes are used with HTML codes. So, by using Action Script 2, PHP, HTML and MySQL (with T-sql) codes in a correct manner, the 2D risk game can be played as a multiplayer game.

Finally, the last game that will be illustrated is "3D risk game". This game is very similar to the "2D risk game", only difference is that the environment of this game is 3D instead of 2D. So to make the platform 3D, some corresponding technologies was needed to be used. The Figure 33 shows the structure of 3D risk game.

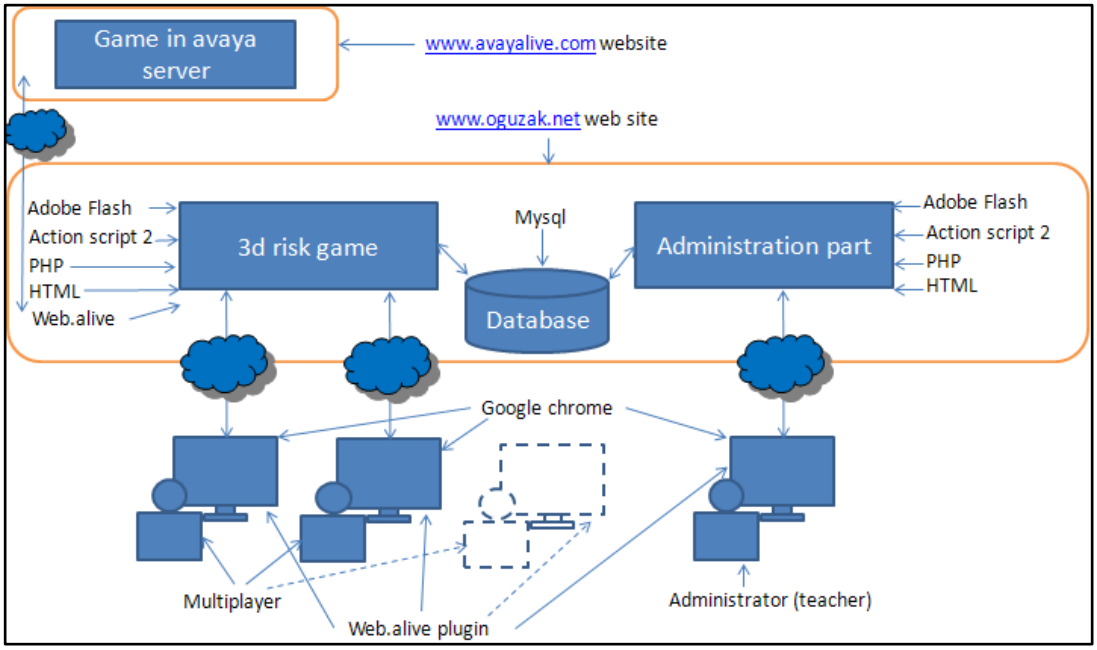


Figure 33. Three dimensional risk game structure

In the 3D risk game, communication between oguzak.net server and the user computers are realized in the same way with the 2D risk game structure. On the other hand, for the user computers there is a need for Web.Alive plugin which is required to display 3D game interface in the browser. Moreover, the communication of the 3D risk game and administration parts is in the same way with the 2D risk game. Only difference is that in 3D game there is an additional Web.Alive technology.

Web.Alive is a 3D game engine which is developed by Avaya. The game which is developed in this platform can be run in the Avaya's servers, so the game file engine stored in www.avayalive.com web site. But because the players need to play the game in their browsers with additional components, the 3D game is displayed from the www.oguzak.net website (the game existing in the Avaya server but imported into our website).

Instruments and Materials

In the study, quantitative data is collected from 5 forms which are ethic form, student information form (SIF), student preferences about learning type questionnaire (SPALT), pretest and posttest. In this part, these data collection instruments will be illustrated.

Ethic Form

Ethic form is a form in which the summary of the study is illustrated. It is given to students in order to make them aware of the study. At the end of this form there is an acceptance part. If students accept to join this study, they sign this form.

In the form some ethical information is included such as; none of the personal information will be shared with anyone, any student can leave the study whenever s/he wants to leave.

Student Information Form (SIF)

The aim of SIF is to collect students' background information and to identify their technology and game usage. In order to identify these issues, the form is developed including the following information;

- Student background information (Student ID, GPA, date of birth, gender, departments and term)
- Students' daily computer and game usage (number of hours for using games in a day, number of hours for using computer in a day, names of three games that students play)
- Students' frequency of technology devices/tools usage (any type of computer usage, cell phone usage, smart phone or pda usage, tablet or pad computer usage, internet usage, social network platform usage, chatting platform usage, email accounts usage, web blog or website usage as a writer, forum usage as a writer)

In the first part of the form, all of the listed elements are included. In the form, student background information and students' daily computer usage parts are collected as a fill-in-blank type except gender part. In the second and final part, students' frequency of technology devices/tools usage is included. In this part 5 points Likert scale type items are used. In this scale, the options are; no-use, rarely, moderately, frequently and always. The degrees are changing from no-use to always use from 1 to 5. In the form there are also some small directions about how to fill in the form.

After the form was developed, two professionals checked the form. They changed some words and phrases to make it more understandable, and they suggested that it should be shorter. In that purpose, author checked the available school resources so that if any of the information could be obtained without asking students. It is found that the information of student departments and terms information can be obtained from school resources. So, these two items were removed from the final form.

After the final form was created, it was applied to a graduate student as a pilot study. She easily filled in the form and said that the form can clearly be understood. The final version of the form is included as Appendix D.

Student Preferences About Learning Type Questionnaire (SPALT)

The third instrument is SPALT. As the name implies, the questionnaire aims to collect students' preferences about a learning environment. For the questionnaire, a literature review was conducted by author and 26 items were listed which are in 5 point Likert scale format. Among these items, 16 of them were used according to findings from the literature and 10 items were taken from the questionnaire of "EGameFlow" which was developed by Fu, Su & Yu (2009). The 10 items had been changed so that they can be applied for testing of different platforms (traditional learning and game platforms).

After the first form of the scale was developed, it was shown to 3 experts. The experts changed some of the items in order to make them more understandable. After that evaluation, some of the items and some terms in the questionnaire were changed.

In the first version of the scale, all of the items were in positive impression form. In these items the choice of "1- completely disagree" had the most negative meaning. However, after corrections 11 of the items were converted to negative impressions. Thus, because the impressions are negative in these items "1- Strongly disagree" had the most positive meaning.

After the corrections, the questionnaire and the student information form were applied to a graduate student as a pilot study. After that study, the student reported the points that she was confused. Then a few items were corrected in order to be understood better and one of the items were excluded because it would both result in a misunderstanding and it was a repetition of another item.

Finally, the questionnaire included 25 items, 10 of them were adopted from EGameFlow scale (Fu, Su, Yu, 2009), 15 of them were created according to literature findings. As a final change of the first form of scale, the order of the items was changed randomly. It is because the student in the pilot study explained that answering similar questions orderly may result in a confusing.

Then, some explanations were added to direct the students on how to fill in the items, and a thanks note was added at the end of the page. After this addition the first form of the questionnaire was completed.

After the form was developed it was applied to a group of students who study the learning content with the 2D game in a laboratory environment. The detail of this study was explained in pilot 1 part. In the pilot 1, after students play the game they complete the questionnaire. Twenty two students filled in this form and internal reliability of the test was calculated by SPSS. Firstly, Cronbach's Alpha was found as 0.708 but in the item total statistics which is shown in Table 10, item 19 showed negative correlations.

Table 10. Item Total Correlations for SPALT

	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Cronbach's Alpha if Item Deleted
q1	93.55	56.165	.447	.688
q2	93.32	53.370	.640	.672
q3	94.05	57.093	.164	.709
q4	92.91	57.706	.348	.696
q5n	93.86	51.838	.545	.671
q6	93.32	56.323	.411	.690
q7	93.55	55.879	.302	.695
q8	93.23	55.994	.414	.689
q9n	92.86	58.219	.357	.697
q10	93.77	53.803	.504	.679
q11n	93.36	57.004	.223	.702
q12	94.05	55.855	.238	.702
q13	93.55	56.260	.353	.692
q14n	93.77	59.708	.051	.715
q15n	93.18	58.727	.142	.707
q16	93.41	57.872	.169	.706
q17n	93.64	58.623	.102	.713
q18	93.36	59.385	.080	.712
q19n	94.45	63.974	-.318	.730
q20	93.55	55.022	.341	.692
q21n	93.27	55.732	.408	.688
q22n	93.27	59.541	.042	.718
q23	93.27	55.827	.443	.687
q24n	94.82	57.013	.158	.710
q25	93.55	60.545	.001	.717

So item 19 is removed from the scale and new Cronbach's Alpha is calculated as 0.730 which shows that the scale is internally reliable. The final correlations are shown in Table 11. Finally the final form of the scale is shown in Appendix E.

Table 11. Item Total Correlations for SPALT after Item Deletion

	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Cronbach's Alpha if Item Deleted
q1	90.55	58.736	.455	.712
q2	90.32	55.942	.642	.698
q3	91.05	60.045	.149	.734
q4	89.91	60.372	.351	.719
q5n	90.86	54.314	.550	.697
q6	90.32	59.180	.393	.715
q7	90.55	58.260	.322	.718
q8	90.23	58.279	.447	.711
q9n	89.86	60.695	.386	.719
q10	90.77	56.470	.499	.704
q11n	90.36	59.671	.224	.725
q12	91.05	58.998	.210	.728
q13	90.55	59.022	.345	.717
q14n	90.77	62.470	.050	.737
q15n	90.18	61.203	.161	.729
q16	90.41	60.729	.158	.730
q17n	90.64	61.385	.100	.735
q18	90.36	61.766	.107	.733
q20	90.55	57.593	.345	.715
q21n	90.27	58.113	.431	.711
q22n	90.27	61.922	.066	.738
q23	90.27	58.303	.459	.711
q24n	91.82	59.870	.149	.734
q25	90.55	63.307	.001	.739

Pretest and Posttest Development

In order to develop the pretest and the posttest, first of all the learning content was asked to the teacher of the lesson before the term started. She explained the scope and the process of the lesson and gave a hard copy of the content which included all the required information for the lesson.

From the hardcopy a list of learning objectives were created. The course will be done for two class hours, for that reason 17 learning objectives were created from the content of the lesson. Thus after the content is rechecked, it is understood that some of the objectives are identifying very similar ideas. For that reason, some of them are merged as wider objectives. So in this period 3 objectives are removed and, as a final form 14 objectives are listed as follows:

Students will be able to;

1. Explain the definition of Multimedia.
2. Identify three kinds of learning outcomes. (later canceled)
3. Identify three assumptions that construct cognitive theory of multimedia learning.
4. Identify dual-channel assumption.
5. Identify limited capacity assumption.
6. Identify active-processing assumption.
7. Identify multimedia principle.
8. Identify contiguity principle.
9. Define coherence principle.
10. Define modality principle.
11. Define redundancy principle.
12. Define personalization principle.
13. Define interactivity principle.
14. Define signaling principle.

In accordance with these 14 items, 14 pretest and 14 posttest questions were developed. As it is understood from the objectives, the content of the lesson consisted of low level objectives. Thus the questions were mainly created depending on memorization. It could be thought as one of the weaknesses of the study but it was thought that if the students remember the content, they can use it as a second step. For these learning objectives, quiz type of game was used, because it was said that

for factual level learning objectives, quiz game is one of the most recommended game type (Dondi and Moretti, 2007).

Initial form of the pretest and posttest were developed first. Then, after the control group studied the content, it is understood that 2nd learning objective was not included in the lesson by the teacher. So, item 2 was removed from both pretest and posttest. Final form of the pretest was available in appendix F, and final form of posttest was available in appendix G.

Data Collection Procedures and Application Details

For the application of the study, 2 pilots and 3 main applications were conducted in the university level school settings. Before the pilots as it was mentioned before, some expert reviews and basic applications on students were done in order to develop first version of the tools. With the help of these procedures, first versions of all forms and games were prepared. After this, there was a need to test newly developed materials on real settings to calculate their reliability and make some changes if it is required. In order to check this, two pilot studies were conducted before the real applications. After the pilots, the second and final forms of the instruments and games were ready to apply. Then, 3 main studies were conducted in 9 different days. In this section the details of these applications will be covered.

First Pilot Study

The first pilot was conducted in another course of the Computer and Education Technologies (CET) department in which 3rd grade CET students were taking instructional design related content. The section was conducted with all the forms

(pretest, posttest, ethic form, student information form and student preferences about learning type) and with the developed 2 2D games (2D elimination game and 2D risk game). All of the application was conducted in 2 lesson hours which was 90 minutes.

In the first part of the lesson, there were 24 students in the lesson. Firstly they took the pretest and they completed it in 15 minutes. But it was difficult to complete this part because some of the students were very slow. Because of this reason it was decided to give a limitation of 10 minutes to pretest part.

Then after they completed pretests, the first game was played in 20 minutes. In this game only a few students could not pass the desired level which is 1200 points over 1500 points. It seems that the targeted level of point is good because students tried to give better answers to reach accepted level. However, although the rules of game identified that they should check the animation, some students did not click on the button, and it is decided that the usage of the part should be emphasized more at the beginning. After that part some of the students gave feedbacks about the game, they reported that:

- The avatar of the game is not friendly but she is scary, there could be a nicer girl as an avatar.
- There are some spelling mistakes in the content.
- The introduction part is not well understood; during the introduction it could be better to have a dark background.
- A student said that there is not an option to change the order of the game, he wanted to leave a question empty and go back to it again.

All students achieved targeted level after failed students tried their chances for the second time. Final game is started with 2D risk game. In the first part of this game, the lecturer explained the aim of final game which was also written on students' screens. For the first question teacher gave direction about the answer entering and students started. But they realized that after their responses are grading,

they could not see their points. It was because the teacher forgot to start a new section in the system. So the teacher corrected the problem and the student restarted the game.

After students gave responses to the questions, a few students realized that their responses were not accepted. Teacher assumed that they forget to refresh their pages after section change. So from that point, it is realized that at the beginning of the session teacher should make sure that all of the students are playing in the correct section. To understand that, a section name button is added to right bottom which is not a control but is a check mechanism. Students should check this before they start the game.

After the game was started in the first period, students were confused about writing a correct answer type, they did not understand that they should write their answers in a correct format, thus from that it was decided that teacher needs to explain the aim of the game, and check whether it is understood or not in the beginning of the game.

There was not time control to write a question for the given answer, for this reason the teacher warned students to be quick but some of the students were very slow. Students who wrote question fast were getting bored. Thus for each question 1 minute time limitation was added to the game. Moreover, at the same time if the time ends, no other question will be accepted. For that, student should send empty questions at the end of the game.

Moreover, although many of the students played the game successfully, some of the students were getting very low points and they were losing their motivation to win the game. To overcome this problem, teacher needed to explain that all the

students have a chance to win the game till the end because there was a final risk part.

Furthermore, there were 15 questions in the risk games but time was not seemed to be adequate to complete them in two hours, so the question number should be decreased to 10 or 13. For this aim the questions some of the questions were cancelled and 10 questions were rearranged. After that correction the question number was decreased from 15 to 10.

Finally the application was completed in 25 minutes. In the last 15 minutes of the lesson teacher gave the post test and scales. In this part, teacher announced the winners as it mentioned in the first part of the game. But a problem about scoreboards observed in the last grading, probably the scores were added wrongly because of a coding error. The problem needed to be identified and corrected. As a result of this problem 2 additional corrections were added.

Second Pilot Study

The second application was conducted to the 3rd grade CET students. This time not all the application forms and games were applied, instead only 3D game was played via a small group of students. Only 7 students joined the application and the game was applied in 20 minutes between. This was because all forms and game parts were the same with the pilot one and only there was a need to check the application problems of the 3D game.

All the students knew the aim of the game at the beginning but the teacher explained it again. When they tried to start to the game, some errors occurred. One student could not open the game link because she could not write the correct link, so in the application it was decided to give students full link instead of making them

write the link. The second problem was that one of the students could not open the environment because of an unknown problem. It was observed that some of the computers might have problems which could arise instantly. So there was a need to test computers just before the application.

When the students opened the environment the game was downloaded and started automatically. It took about 4 minutes to download (the environment was about 7.9 MB). After the game was downloaded, students played the game. According to game playing, some change decisions were made. Firstly because students were using the environment for the first time, they should learn how to use it. Thus the teacher had to make some crucial introduction for playing the game for about 5 minutes which includes how to move the avatar, how to click a control browsers, how to enter inputs to the game. Moreover, in the first version of the game there was only one interaction panel which was inside of the 3D game environment (in computer screen) and it was observed that the students hardly used this control in the environment. It is just because the Flash usage in the environment was problematical. The flash application was not working properly with the environment. So it was decided to put a second flash interaction panel next to game play screen. Finally there were two coding errors related to dynamics of 3D game environments; the scoreboard was not dynamically reloaded and in the input panel the risk panel was appearing although it should not appear. So the two problems had to be fixed.

After students played the game, they reported that the controls of the game should be more feasible, it was difficult to control some of the elements. And they also reported that they liked the environment, it was enjoyable to interact in the environment. With these remarks the second pilot was completed.

Application for Traditional Learning Group

The application of traditional learning groups was completed in 5 different days. As mentioned before the traditional learning group consisted of two sections of the course. For both sections, pretests were applied in the first day. Then the teacher presented the lecture after one week in which the two sections of the students were studied together. Finally the posttests were applied within the following 2 days. In this part, the details of these applications will be illustrated.

In the first application day there were 11 students in the class. In the first 10 minutes the teacher and the facilitator (the person who applied the study) made some explanations about the course. After that the facilitator explained the study and gave students the ethic form which included all details about study and served as an application acceptance form. The students who wanted to join to the study signed the form in that part and accepted to join the study. The pretest was given to the 8 students and 10 minutes were given to these students. They were told that they would see the principles of multimedia design in the next lesson and they would be using their knowledge in their studies in the course. Thus this application ended.

The second application day had the same format with the first application in which the second section filled the pretest. In the application there were 22 students. Again in the first 10 minutes facilitator explained the details of the lesson. After explanation facilitator gave the ethic form, students read and signed. In that part 19 students accepted to join. The pretest form was given to 19 students and they were given 10 minutes but because of the number of students were high, this time this part continued for 13 minutes. In the remaining part again the Power Point usage was shown. Again students were told that they would study the Mayer's principles of

multimedia learning unit contents in next lesson and they would use them in the following lessons.

The third day of the application was the main application day in which students from both of the sections studied the learning unit. The application was conducted for 100 minutes. At the beginning of the session the teacher was ready and there were 24 students in the classroom. But before starting the session, teacher needed to restart computer because of a technical problem. She also changed the places of some chairs near the board because there were no students in the front line of chairs. After these preparations the lesson started. In the first 5 minutes late students joined the class and the number increased to 33.

During the session the teacher tried to present the learning unit by creating the interactions with the students. She asked questions and tried to take correct answers from the students. Some of the students participated in the lesson by answering the questions. The teacher encouraged the participation by her smiling and motivating style. Sometimes students reached the correct answer easily, sometimes their responses were not related to the content.

At the beginning of the session, teacher opened a learning management system that students were already using in the course. By using the projection screen, she talked about the students' comments on previously asked questions. This was the introduction part and it took about 5 minutes. After that, teacher started to the lesson by asking questions about the learning unit. After this discussion which took 20 minutes, teacher started to show a Power Point presentation which includes the main points of the learning unit. During this part she used 3 different Power Point slides which include images, texts and sounds about the learning unit. During these slides teacher sometimes asked questions and took answers from the students but

sometimes she preferred to make direct explanations. This part continued about an hour.

When the presentation ended, the lesson was completed. At the end of the session, facilitator explained the reason of filling in the forms and 31 students filled in the forms in 10 minutes. Two people did not have time; they took the questionnaire and form with them. The main session was completed.

Then the students needed to fill in posttests. Both of the session filled in the forms within 2 days. In the first group there were 11 students and they filled in the forms in 13 minutes. Because some students started to fill in a little late, the average posttest completing time for a student was probably 10 minutes. In the second session, 27 students joined the lesson. Again although posttest completion time was 15 minutes, the average time for each student was about 10 minutes. Thus when the students completed the posttests, the application for traditional learning group was completed.

Application of 2D Game Based Learning Group

The 2D game application was done in two different days. In the first day there were 25 students in the class. Because there were absent students at the beginning of the session, facilitator decided to apply the pretest later. Afterwards at the application time teacher explained the aim of the study in 5 minutes and gave them the acceptance forms. In this section all the students accepted to join to the study. During this period some of the students were not clear about some items in the ethic form, and the facilitator replied their questions. Finally facilitator gave them pretests and they completed it in 15 minutes.

The second application day was the main application day for the 2DGLG. In this day there were 22 students in the class. In the beginning of the session the facilitator explained the rules and aims of the first game which was "risk elimination game". And all class answered the first question together with directions of the facilitator. Afterwards, the students started to play the game individually. Although half of the class completed the game at the end of 12th minute, all of the class completed it in 20 minutes. During this part one student was cheating and his data were excluded from the study. As the aim of the game, students needed to gain 1200 points over 1500, but if anyone gets 1500 point, s/he will get a gift. At the end of this part, 2 students made 1500 points as full, and 6 of them made 1450 which means they made only one mistake. So students who get both 1450 and 1500 points were given chocolates as gifts. During this period the class was observed as very silent and everybody seemed to enjoy the game.

Then the second part was started. In this part the teacher explained the rules of the game and the whole class answered the first question together with the directions of the facilitator. During the 2nd game all students replied each question at the same time, but a problem occurred for a few students in the first question, and for the whole class in the next questions. The problem was about grading the students' success and it was probably because of slow internet connection but it is solved; when a student has grading problem the facilitator made a correction in his/her grading. During this period it seemed that the students saw the game as a real competition and they tried to make good points. But because of negative points some of them were discouraged and even a few of them wanted to leave the game. Thus the final game competition was completed and the "great risk" part was just started. In this part, the students who have less than 500 points or negative points they can

risk up to 500 points. If they have less than -500 points, they can risk up to their whole points, such as if a student has -1000 points s/he can risk 1000 points. And the students who have more than 500 points can risk up to their points. At the end of the final risk part, the first three students were determined and they were given their prizes which were chocolates. The second game was completed in 35 minutes.

After the game was completed, all students filled in the information form, posttests and the questionnaire. This period was completed in 15 minutes. All of the participants were given chocolates for their participation. It seems they enjoyed the game in spite of small grading problems during the game; two males are asked if the small problems disturbed them; they said that it did not. Moreover three girls were asked about how they found the questions either difficult or not? They responded that they learnt from the animations as well, but they did not concentrate on the names of the principles which were asked in the second part. So they thought that they learnt better than what the tests measured. So, 2D game application was completed.

Application of 3D Game Based Learning Group

The 3D game application was completed in 2 days. In the first day there were 23 students in the class. Firstly, the facilitator explained the details of the study and stated that they would use the learning content in the course later. After that, the facilitator gave the ethic forms to students. Students read the forms and some of them asked questions about the study. But when they took responses all students accepted to join to the study. Thus the facilitator gave them the pretest and they completed it in 15 minutes.

The second application day was the main application day. This day because of the 3d game platform, facilitator started preparations 90 minutes before the application. There were 28 computers in the laboratory and all were checked. For the application each participant need a computer, internet connection, 3D game environment software (Web.Alive plugin), latest version of Macromedia Flash Player, and headphone with microphone, web browser (chrome working best with the environment). Moreover there was also need in the server side which was 3D environment framework for 25 students (avayalive.com), a PHP server, a database (MySQL).

As a preparation part, in the laboratory computers were checked and missing software was installed. Firstly, the "chrome" was installed about to 10 computers. Secondly, the framework of the 3D game was already installed 1 week ago and they checked whether they work correctly or not. The 3D game has an installation packed which should be downloaded each computers. It was about 8 MB and it was installed in 5 minutes to each computers. Thirdly the elimination part was opened in all computers. Finally, the headphones were tested in each computer. During this period it was understood that some of the headphones were not working. So the headphones were added to 20 computers. So everything seemed to be ready for the game. Because the number of computers is more than the number of students, only 23 computers were prepared for the application. The preparation period took about 90 minutes.

At the beginning of the session 19 students were ready to start the application. The teacher reported that; if the students take at least 1200 point, they can join the final game. Moreover if they take 1500 point, they will win a gift. The teacher explained the aims and rules of the first game. All students answered the first

question together and the students started to play the game. It was observed that all of the students were watching the videos and tried to achieve the desired point. This part takes about 20 minutes. All students passed the desired level but no student took 1500 points in this session. However the facilitator gave the prizes of the students who took 1400 points or more. There were 2 students who took 1450 while 4 students who took 1400. They were given gifts as chocolates. During this period no problems occurred. Everyone completed the game and it seems they found this part enjoyable.

Then the final game which was 3D risk game was started. Students opened the game environment and teacher gave directions about how to play. The students moved around the 3D game environment by using the keyboard and mouse. All students chose a desk in the game environment then. During this period some students reported that they hardly found an empty desk in the game. Facilitator explained the rules of game, and the students entered their answers for the first question. Then the teacher opened the administrator page and graded the responses. During this process one of the students took an error about 3D game environment and worked with another computer. The game continued for new questions, each time the first person chose a new question and whole class entered their answers together. In some of the questions it was observed that even nobody could give the correct answer. It seems the students found the questions difficult. There were lots of empty questions and wrong answers. So the facilitator made some explanations at the end of the questions. This part is completed in 40 minutes. There were again some grading problems but the facilitator corrected them. In the final risk part students risked their point and they played this part. At the end the top three students got their prizes.

At the end of the section one student reported that she found this period very unsuccessful. She was the girl who had technical problems in the first part of the session. She explained that she did not saw the relation between the learning content and the course. She added that “the game is not a good platform to learn”.

At the end of the session teachers gave the forms to the students and they completed the three forms in about 20 minutes. At the end of the session the teacher gave chocolates to all the students for their participation. Thus, the 3D game based learning session was completed successfully.

CHAPTER 5

RESULTS AND FINDINGS

As is illustrated in the methodology chapter, 3 research groups in the study were subjected to pretest, posttest, SIF and SPALT. Using the data obtained by these instruments, the initial group differences based from the aforementioned 5 hypotheses were tested and the findings are reported in the following sections.

Initial Differences Among Groups

In order to test whether there is an initial difference between groups' pretest scores or not, the Kruskal-Wallis test, a nonparametric statistical testing method to identify whether samples originate from the same distribution, ("Kruskal-Wallis one-way analysis of variance", 2013) was applied. The number of participants and their descriptive statistics in pretest scores are shown in Table 12. According to the ranks a Chi-Square value of 1.809 is obtained with a significance level of 0.405. This value indicates that there is not any significant difference among students' pretest scores in each group ($\chi^2(2, N=60)=1.809$, $P=0.405$) with a mean rank of 33.78 for traditional, 32.25 for 2DGLG and 26.63 for 3DGLG.

Table 12. Mean Ranks of Pretest in Kruskal-Wallis Test and Descriptive Statistics

Group	#participants	Mean Rank	Minimum	Maximum	Mean	Std. Deviation
tradLG	20	33.78	2	8	4.70	1.63
2DGLG	21	32.25	2	8	4.63	1.89
3DGLG	19	26.63	1	10	4.10	2.02

Moreover, the descriptive data shows that tradLG has a mean of 4.70 with a 1.63 standard deviation, 2DGLG has a mean of 4.63 with a 1.89 standard deviation and 3DGLG has a mean of 4.10 with a 2.02 standard deviation. As a result, pretest score differences among three groups are not significantly different.

As a second difference, student's literacy grades were tested using the Kruskal-Wallis test. Table 13 shows the values of perceived computer literacy averages among groups and related descriptive statistics.

Table 13. Mean Ranks of Students' Perceived Computer Literacy in Kruskal-Wallis Test and Descriptive Statistics

Group	#participants	Mean Rank	Minimum	Maximum	Mean	Std. Deviation
tradLG	20	24.70	2.50	4.40	3.21	0.51
2DGLG	21	34.76	1.90	5.00	3.53	0.72
3DGLG	19	31.89	2.20	4.30	3.39	0.56

According to the above ranks a Chi-Square value of 3.591 is obtained with a significance level of 0.166. This value indicates that there is not any significant difference among students' perceived computer literacy scores in each group ($\chi^2(2, N=60)=3.591$, $P=0.166$) with a mean rank of 24.70 for tradLG, 34.76 for 2DGLG and 31,89 for 3DGLG. Similarly Table 14 shows an average of daily computer and game usage hours for each group.

Table 14. Average Daily Game Play and Computer Usage of Students

Group	#participants	Avrg. Game.	Std. Dev.	Avrg. Comp.	Std. Dev.
tradLG	20	0.23	0.30	2.73	1.86
2DGLG	21	0.38	0.55	3.20	1.78
3DGLG	19	0.32	0.52	2.28	1.41

According to the results of the Kruskal-Wallis test with average times in Table 14 there is not any significant difference among groups in terms of average daily game play(χ^2(2, N=60)==2.328, *P*=0.312) and average daily computer usage(χ^2(2, N=60)=3,635, *P*=0.162).

As a result of these tests, one can conclude that there is not any significant difference among groups in terms of their pretest and perceived computer literacy scores, and in terms of daily computer usage and game play.

Testing Normality

All three groups' learning gains in the study were tested as to whether they were normally distributed or not. In order to test the normality for the learning gains - defined as the difference between posttest and pretest scores and also referred to as achievement - Kolmogorov-Smirnov and Shapiro-Wilk tests were applied. The results are shown it Table 15.

Table 15. Pretest-posttest Difference Normality Tests

	Kolmogorov-Smirnov[a]			Shapiro-Wilk		
	Statistic	df	Sig.	Statistic	df	Sig.
tradLG	0.155	20	0.200*	0.954	20	0.432
2DGLG	0.128	21	0.200*	0.939	21	0.205
3DGLG	0.181	19	0.103	0.929	19	0.166

According to the Kolmogorov-Smirnov test all groups are normally distributed (in tradLG P=0.200, in 2DGLG P=0.200, in 3DGLG P=0.103). Similarly, Shapiro-Wilk test results show that all groups are normally distributed (in tradLG P=0.432, in 2DGLG P=0.205, in 3DGLG P=0.166).

However, Hogg and Tanis (1997) identify that for a sample to show normal distribution, the sample size should be more than 25 or 30. It should be mentioned that the stated numbers are not exact: the number of participants in each group in the study tended to be less than these numbers. As a result it would be more valid to accept the groups as nonparametric. Thus while testing the stated hypotheses, nonparametric tests were conducted. Also, as a cross check, the parametric tests were applied and it is found that the results of parametric tests are perfectly parallel to corresponding nonparametric tests. As a result when both types of tests are applied to test the hypothesis, similar results are found but in the following sections only nonparametric test results will be reported.

Results of Hypotheses Testing

The first hypothesis argues that there is a meaningful relationship between students' perceived computer literacy level and their achievement using Mayer's multimedia learning principles as the learning unit for the three groups. Three analyses were conducted for each group to test this hypothesis; Table 16 shows the relationship between perceived computer literacy and achievement in each group of the study.

Table 16. Correlations between Perceived Computer Literacy and Achievement in Groups

Group	Number of Participants	Spearman's Rho for achievement and perceived computer literacy level	Significance value
TradLG	20	-0.06	0.799
2DGLG	21	0.31	0.171
3DGLG	19	0.01	0.967

To test the hypothesis, perceived computer literacy of the three groups of students were correlated with their achievement scores in the specified learning unit. For that purpose Spearman's Rho test was selected because the test gives the correlation between the two scores in nonparametric distributions (Slate and Uojas-LeBouef, 2011). By looking at the values in the tables, it was found that there are positive correlations between student's perceived computer literacy level and pretest-posttest scores in 2DGLG ($rs[21]=0.31$, $P=0.171$) and 3DGLG ($rs[19]=0.01$, $P=0.967$) but none of the relationships were found to be statistically significant. These relationships are positive but weak. On the other hand, in the tradLG there is a

negative correlation between the two variables but the relationship is again not statistically significant (*rs*[20]=-0.06, *P*=0.799) and weak.

According to these findings, there is not any significant relationship between the students' perceived computer literacy level and their achievement level in any of the learning environments in the specified learning unit. So the first hypothesis is not verified.

For the second hypothesis it is argued that there will be a positive relationship between students' perceived computer literacy level and their learning environment selection points in the specified learning unit. To test this hypothesis again nonparametric Spearman's Rho tests were applied for each group for the same reason as in the first hypothesis. The findings are shown in Table 17.

Table 17. Correlations between Perceived Computer Literacy and Learning Environment Selection Scores

Group	Number of Participants	Spearman's Rho for perceived computer literacy level and learning environment selection scores	Significance Value
TradLG	20	0.09	0.716
2DGLG	21	-0.13	0.562
3DGLG	19	0.36	0.127

According to the test results interestingly while in tradLG (*rs*[20]=0.09, *P*=0.716) and in 3DGLG (*rs*[19]=0.36, *P*=0.127) there are positive correlations between perceived computer literacy and environment selection scores, there is a negative correlation between scores of the two variables in 2DGLG (*rs*[22]=-0.13, *P*=0.562). However none of the correlations are statistically significant and they are weak.

These results show that there are not any significant relationships between students' perceived computer literacy level and their environment selection points in any of the learning environments. Hence hypothesis 2 is also not verified.

The third hypothesis argues that there will be significant learning gains in each learning environment. In other words, each group's achievement in posttest will be significantly higher than their pretest scores. To test this hypothesis, a Wilcoxon Signed Rank Test is used because the test is used to compare paired samples under nonparametric conditions ("Wilcoxon signed-rank test using SPSS", 2013). The descriptive statistics about pretest and posttest in each group is given in Table 18. Students' pretest and posttest scores are compared in each group with Wilcoxon Signed Ranks Tests.

Table 18. Descriptive Statistics about Pretest and Posttest Scores of Groups

	N	Mean	Std. Deviation	Minimum	Maximum
Traditional Pretest	20	4.70	1.63	2	8
Traditional Posttest	20	8.35	2.46	5	13
2D game Pretest	21	4.76	1.84	2	8
2D game Posttest	21	7.43	1.78	4	11
3D game Pretest	19	4.10	2.02	1	10
3D game Posttest	19	6.84	2.87	1	11

(Mean=8.35, S.D.=2.46) is higher than their pretest mean scores (Mean=4.70, S.D.=1.63), confirming the hypothesis. According results of Wilcoxon Signed Ranks test results in Table 19, this difference is verified statistically (Z=-3.48, *P*=0.000).

Table 19. The Wilcoxon Signed Rank test Results for Groups

	# Participants	Sum of Ranks (Negative)	Sum of Ranks (Positive)	Z	Significance
TradLG	20	6	184	-3.48	0.000
2DGLG	21	13	197	-3.58	0.001
3DGLG	19	13	140	-3.02	0.002

Moreover, according to these descriptive statistics the 2DGLG posttest mean scores (Mean=7.43, S.D.=1.78) are higher than their pretest mean scores (Mean=4.76, S.D.=1.84). According to the results of the Wilcoxon Signed Ranks in Table 19, the difference between the scores is statistically significant (Z=-3.58, *P*=0.001).

Finally the descriptive statistics shows that the posttest mean scores of 3DGLG (Mean=6.84, S.D.=2,87) is higher than their pretest mean scores (Mean=4.10, S.D.=2.02), further confirming the hypothesis. As shown in Table 17 according to Wilcoxon Signed Ranks test the difference between the two tests are statistically significant (Z=-3.02, *P*=0.002).

As a result, by using Wilcoxon Signed Rank test it is found that posttest mean scores are significantly higher than pretest mean scores in all groups. So in all 3 groups, students' achievement levels were significantly increased. The learning settings helped students to learn. So, hypothesis 3 is verified.

Furthermore, hypothesis 4 states that there are differences in students' environment selection scores. The descriptive statistics are given in Table 20. According to the table, the environment selection mean scores of 2DGLG is 3.83 with a 0.41 standard deviation, tradLG is 3.48 with a 0.56 standard deviation and 3DGLG is 3.36 with a 0.56 standard deviation.

Table 20. Descriptive Statistics of Student Environment Selection Scores in Groups

	N	Minimum	Maximum	Mean	Std. Deviation
TradLG Envr. Select. Score	20	2.54	4.71	3.48	0.56
2DGLG Envr.Select. Score	21	3.08	4.63	3.83	0.41
3DGLG Envr. Select. Score	19	1.88	4.25	3.36	0.56

Moreover, Table 21 shows the results of Mann-Whitney U tests which is used for the group comparisons to identify if there are differences among the groups' learning environment selection scores.

Table 21. Mann-Whitney U Test Ranks for Comparing Learning Environment Selection Scores among Groups

Comparison	Groups	N	Sum of Ranks	Mann Whitney U	Significance
tradLG vs 2DGLG	tradLG	20	339.5	129.5	0.036
	2DGLG	21	521.5		
tradLG vs 3DGLG	tradLG	20	413	177	0.715
	3DGLG	19	367		
2DGLG vs 3DGLG	2DGLG	21	529	101	0.008
	3DGLG	19	291		

According to the tests results, it is found that the difference between means of environment selection scores of tradLG and 2DGLG (U=129.5, P=0.036) and 2DGLG and 3DGLG (U=101, P=0.008) are significantly different in the favor of 2DGLG. On the other hand, there is not any significant difference between the means of the environment selection scores of tradLG and 3DGLG (U=177, P=0.715). These findings show that the 4th hypothesis could only partially verified. Although 2DGLG get significantly higher scores than tradLG in the environment selection scores, 3DGLG did not get higher scores.

Finally, the 5th hypothesis suggests that game based learning groups get significantly higher scores in achievement tests than tradLG. In order to test this hypothesis Mann-Whitney U test is applied to the groups to compare them. Descriptive statistics for the pretest and posttest were previously given in Table 18, and Table 22 shows the results of Mann Whitney U tests.

Table 22. Mann-Whitney U Test Ranks for Comparing Achievement Scores among Groups

Comparison	Groups	N	Sum of Ranks	Mann Whitney U	Significance
tradLG vs 2DGLG	tradLG	20	451.5	178.5	0.408
	2DGLG	21	409.5		
tradLG vs 3DGLG	tradLG	20	423.5	166.5	0.506
	3DGLG	19	356.5		
2DGLG vs 3DGLG	2DGLG	21	427	196	0.924
	3DGLG	19	393		

Using these results the differences among achievement scores of the groups are compared. According to descriptive statistics in Table 23, the mean achievement score of tradLG is 3.65 with a 3.07 standard deviation, 3DGLG is 2.73 with a 3.18 standard deviation and 2DLG is 2.67 with a 2.35 standard deviation. When these results are compared using Mann Whitney U tests, none of the groups have significantly higher achievement level than others. The findings show that the achievement score difference between tradLG and 2DGLG (U=178.5, P=0.408), between tradLG and 3DGLG (U=166.5, P=0.506) and between 2DGLG and 3DGLG (U=196, P=0.924) are not significant.

Table 23. Descriptive Statistics of Achievement Levels of Groups

	N	Minimum	Maximum	Mean	Std. Deviation
Traditional Achievement	20	-2	9	3.65	3.07
2D game Achievement	21	-2	6	2.67	2.35
3D game Achievement	19	-2	8	2.73	3.18

In the light of these results the 5th hypothesis which argues that "there is a significant difference among groups" is not verified, and again actively rejected.

CHAPTER 6

CONCLUSION

The first aim of this study was to understand whether perceived computer literacy – which is thought as an indicator of being a member of the new generation - has an impact on either on students' achievement (h1) or students' learning environment selection scores (h2).

When testing the two hypotheses, although some correlations exist between the parameters, none of them are found to be statistically significant. So it is concluded that perceived computer literacy level of the Faculty of Education Students in Boğaziçi University does not affect either their achievement or their environment selection scores in the 'Principles of Multimedia Design' learning unit. This means that whether the students' perceived computer literacy level is high or low does not affect the students' success in traditional and game based learning environments for the learning unit. Also their perceived computer literacy level does not affect their preferred learning environment among traditional, 2D and 3D game based environments for the learning unit.

Because Prensky (2001) points out the relation between being a member of new generation and possible failure in the traditional learning environment, it was expected that there would be a negative correlation between perceived computer literacy and students' success in traditional learning environment, and positive correlations between the variables in game based learning environments. However this study suggests a rejection of this theory.

It should be pointed out that, as with any study, there were mitigating factors that could explain the gap between the results of this study and those of Prensky's.

One possible reason behind these differences could be the fact that the study group was unusually challenging. Furthermore, it was difficult to show any relationship between the targeted groups in terms of learning gain and environment selection. This could be because the participants of the study are studying in one of the top universities in Turkey and receive some of the highest scores from the national university entrance exam, and therefore there could conceivably be a low level of diversity regarding both their success and their perceived computer literacy level. This study indicates that perceived computer literacy does not have any effect either on their environment selection scores and achievement, but as it more specifically indicates that there is no effect in the specific environment in which the study was conducted, further research is required to be able to make broader conclusions across all classes and sections of global society.

Other two aims of the study were first to test whether Faculty of Education students would make significant learning gains in the learning unit in traditional, 2D and 3D learning environments (h3), and second whether there are differences between their success in the three learning environments (h5). For the first part in all three environments, students made significant learning gains. So students gained from the learning unit in traditional, 2D and 3D game based learning environments. For the second part when the success of the students in the three learning environment are compared, no differences between the groups are found. Students were equally successful in the learning unit in all three environments.

Garris et al. (2002) explains that one of the powers of computer games in education is in being effective tools for enhancing learning and understanding complex subjects. In this manner the first part of the findings supports this idea; in both of the game based learning groups, the students learned the unit. The problem of

whether game based learning is superior to traditional learning environment (e.g. from Tüzün et al., 2009; Kebritchi et al. ,2010; Randel et al., 1992) is rejected based on this study. None of the game based learning groups are superior to the traditional learning group for Faculty of Education students of Boğaziçi University for the "principles of multimedia design" learning unit.

There may be a number of reasons that games didn't result in better learning gains compared to the traditional learning environment. Firstly, as Prensky (2001) suggests, the reason behind this result could be the particular design of the learning games. In this study the genre of computer games was a "quiz game" and some combinations of game elements were included as a part of the games like competition, feedback, multimedia support etc. (no special feature of 3D games was added to the 3D group except environment). In this manner the type of game may not have been suitable for the specified learning unit. Hence, another potential explanation is the fact that the features of these games which result in learning may not be entirely clear (Garris et al., 2002). If some of the features of the games were to be changed, they could in theory result in different findings. So this fact again addresses the need for specification in the qualities of games. Finally another reason behind this result could be the quality of the teacher in the specific traditional learning environment. Because the study is applied in one of the top universities in Turkey, the teacher of the class (who was an Assist. Prof.) is particularly well qualified and was unusually effective in a lecture setting. Possibly because of the professor's high degree of qualifications they were able to match the ability of the computer game to produce results from amongst the students.

Finally, the last aim of the study was to determine students' preferred learning environment among the traditional, 2D and 3D learning environments (h4).

According to the SPALT results the Faculty of Education students' preferred learning environment for the "principles of multimedia design learning unit" is a 2D game based learning environment. A 2D game environment gets significantly higher scores than the 3D game environment or a traditional learning environment, and no differences were found between the students' preferences in the other two environments. As many authors claimed (e.g. Annetta, 2008) games have a potential of improving students motivation. In this manner, it is not surprising that students select 2D game environments as a preferred learning environment. On the other hand, why the 3D game environment wasn't preferred by students should be further argued.

One reason behind that result could be the existing game habits and familiarities of the students. The students of the study were new to the 3D game environment and although there was a training part at the beginning, it could be that this was not enough for them. 2D games may be easier to control and more familiar to the students. Hence, in the study the majority of the students were girls and according to Karakus et al. (2008) girls prefer relatively simpler type of games like "Mario". Another reason for this preference could be the genre of the game. Quiz games would be more suitable for playing in 2D game environments than 3D game environments. For example Squires (2008) explains that games are good for problem based learning. So, 3D games may provide better functions for this kind of learning. Actually, many specific elements of 3D games are not required for quiz games like collaboration or creating some elements of virtual reality. Moreover, for the current study the aim was to evaluate solely the effect of learning environments for quiz games, not the effect of various game types. So, if the game type or any combination

of the elements in the environment were to be changed or the features of 3D games were added, 3D games could potentially become a preferred learning environment.

Limitations of the Study

The study was conducted in real school settings. Because it was done on different days and the participation to the lessons varied, potential participants occasionally were absent from the studies. Furthermore, the number of students who registered for the selected classes was lower than an ideal maximum sample size, so as a result of this and the fact that attendance was less than 100%, the number of students in the study was necessarily limited and presented a limitation of the study.

Another limitation is that there was a difference for the application times of posttests. Because the schedules of the sections were different and there were time constraints, there was less than 2 days delay for applying to posttests in the traditional learning environment. This again results from applying the study in real settings. But because approximately equal times are given to all groups this didn't result in a serious problem.

Finally, as cited in the previous chapters there were some difficulties in the application of the games in the classes. As Tüzün (2007) points out there were a number of difficulties in the application of games in real settings like technical problems in application, and lack of technical personnel in the school. In the application some problems occurred during the games like bad internet connection and small grading errors which occasionally resulted in small delays. However, these problems were recovered during the application and taken into account through the feedback from students. They did not have any negative effect for the application.

Suggestions for Future Research

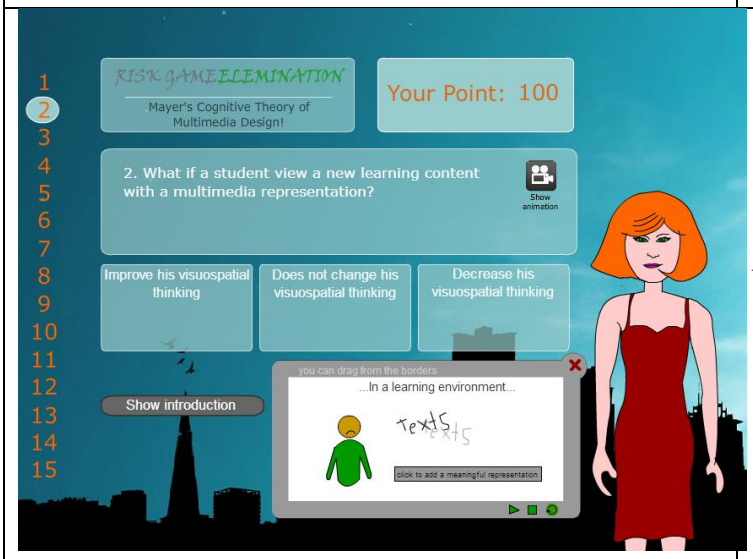
Future studies should test similar learning environments for higher level learning objectives which could require different genres of games. It would be meaningful to test different learning objectives with different genres of games. A potential result of these studies would ideally be a common conclusion that could be reached since some type of the games are better for some types of the learning objectives as Prensky (2001) and Dondi and Moretti (2007) pointed out. Additional studies about students' preferred learning environments would ideally indicate that the preferred learning environment can change for different learning objectives.

Finally, if this study were be replicated by adding more features of the 3D game environment, like more virtual reality elements and collaboration, the conclusions of this study could be further confirmed and built upon.

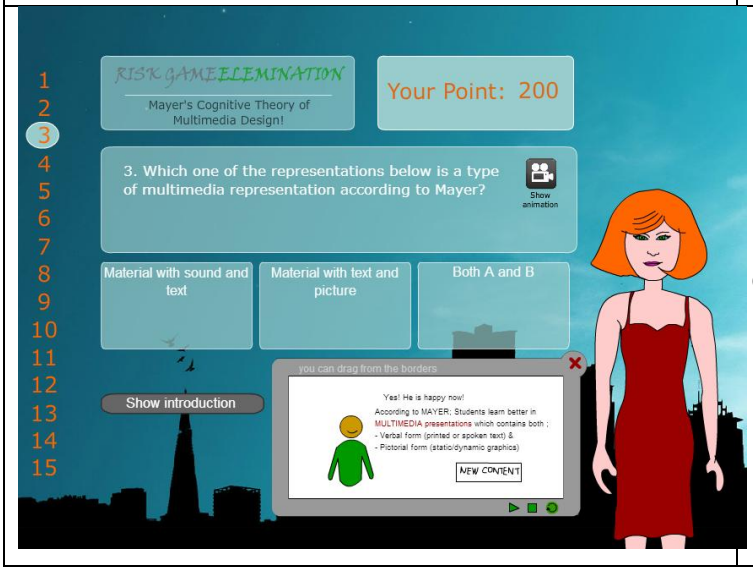
APPENDIXES

Appendix A : Screens of Risk Elimination Game

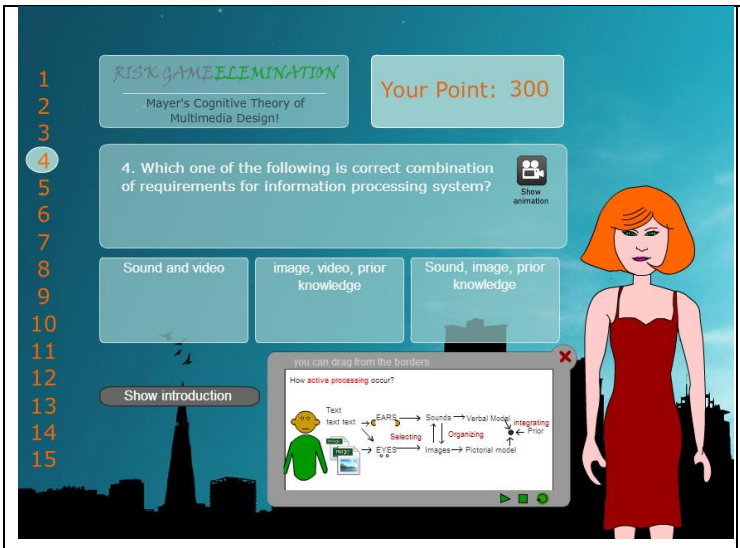
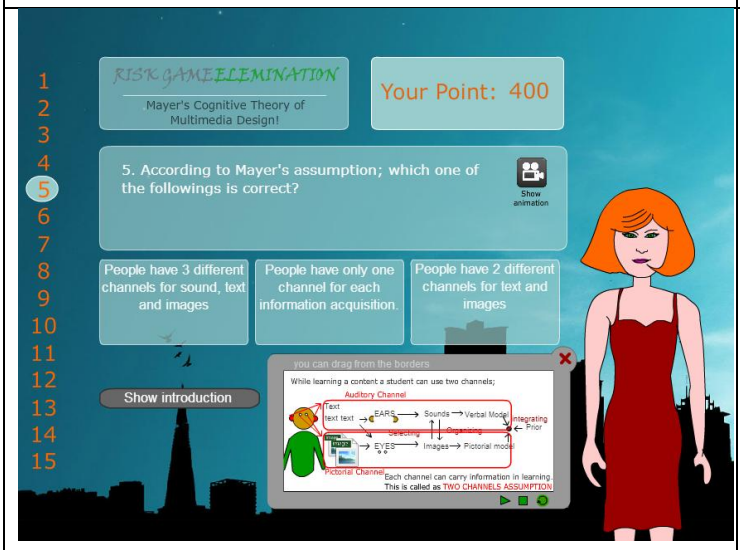
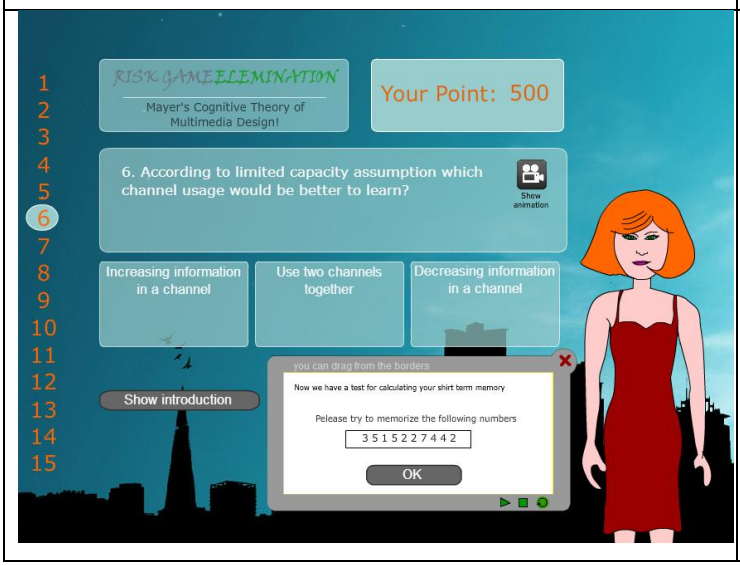
a. First question screen

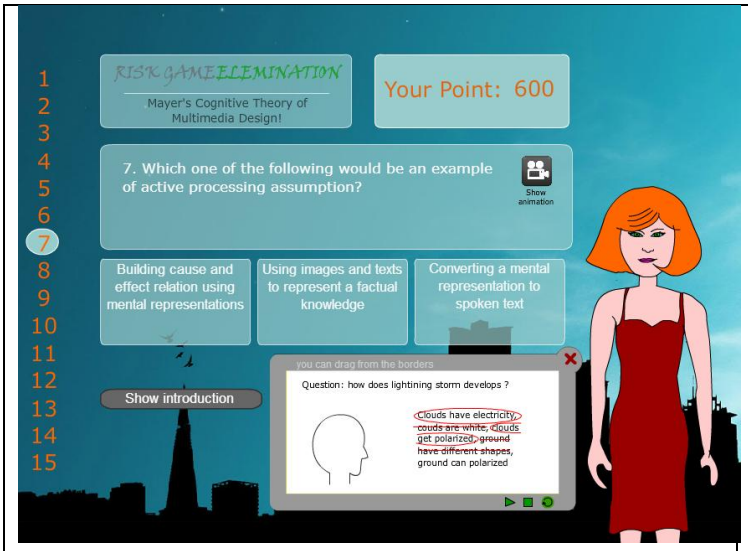


b. Second question screen

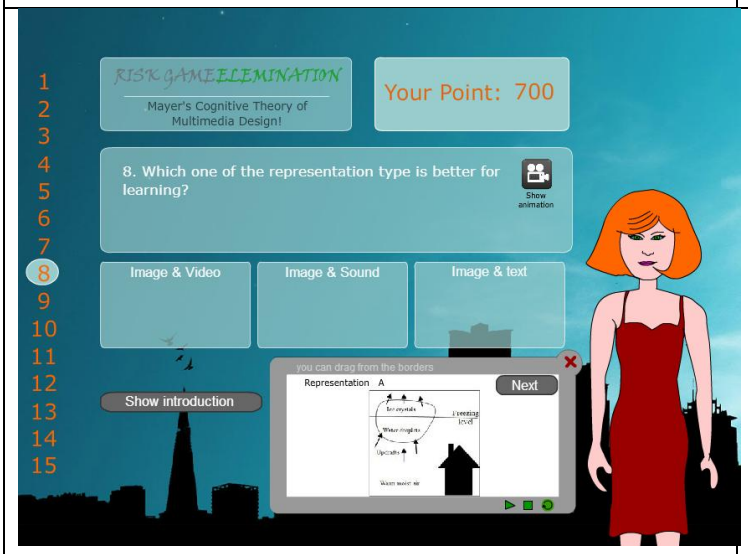


c. Third question screen

	d. Fourth question screen
	e. Fifth question screen
	f. Sixth question screen

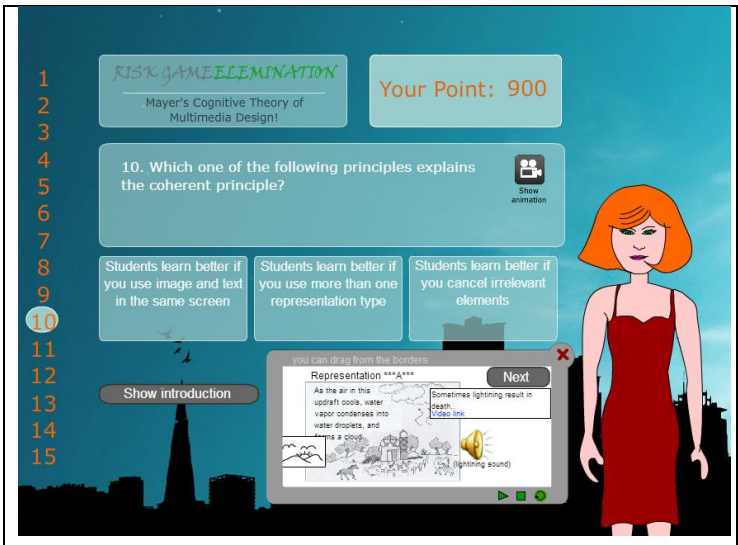
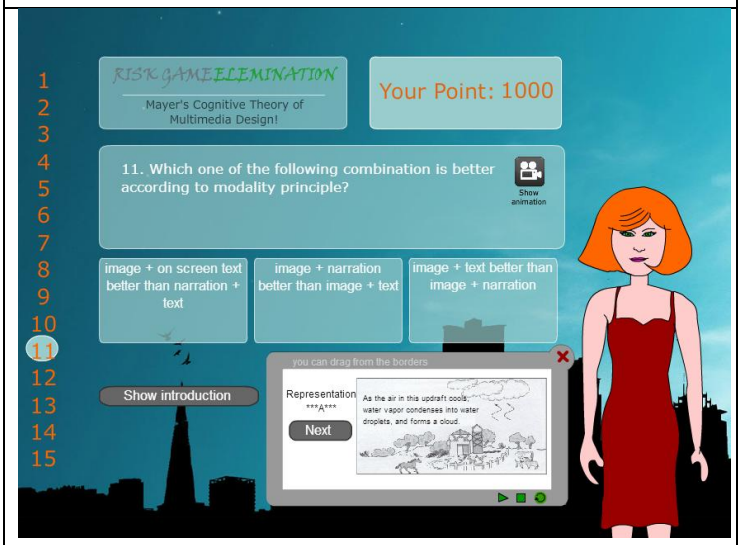
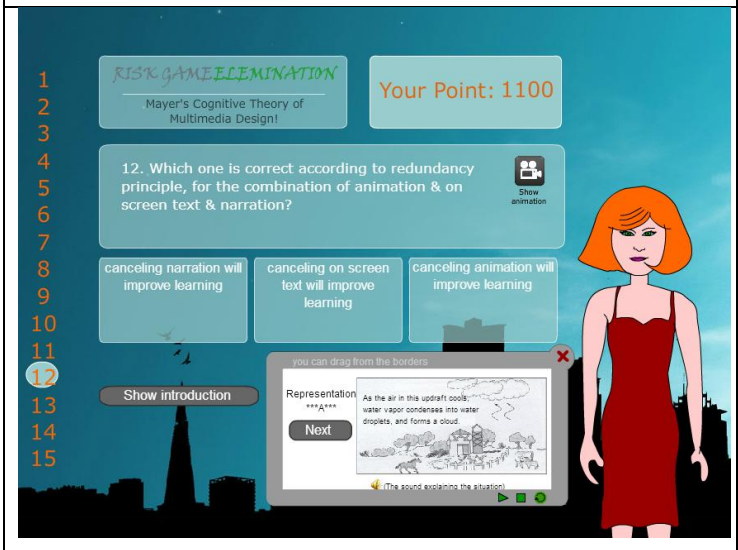


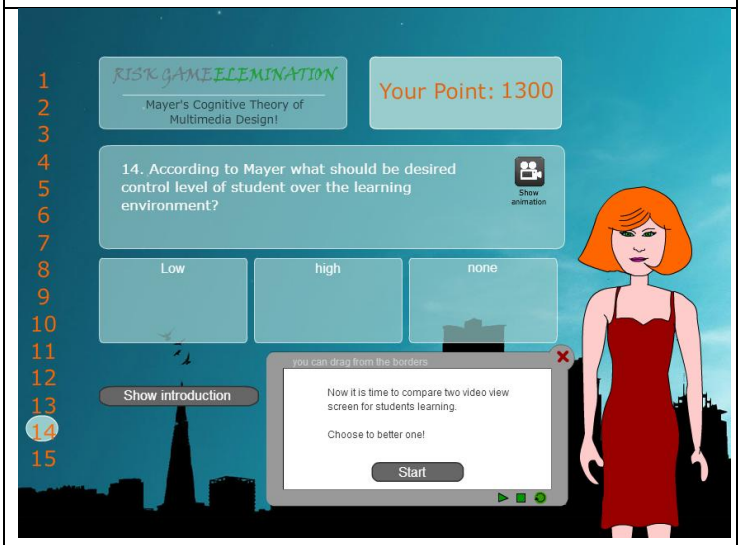
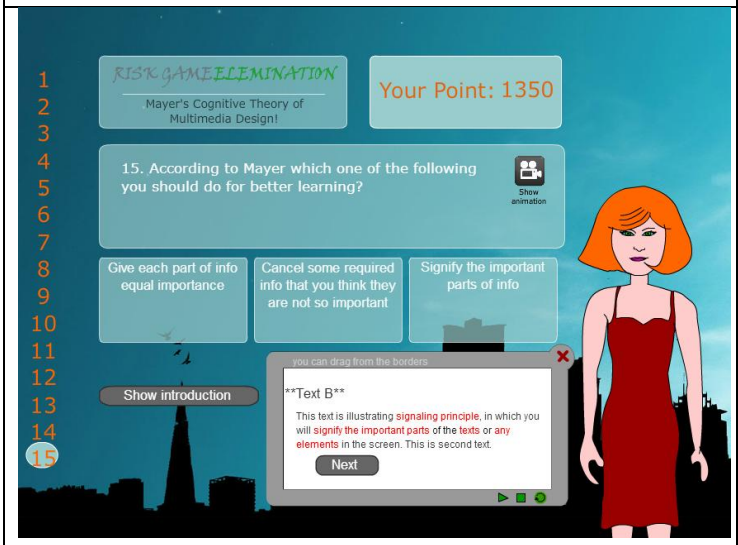
g. Seventh question screen



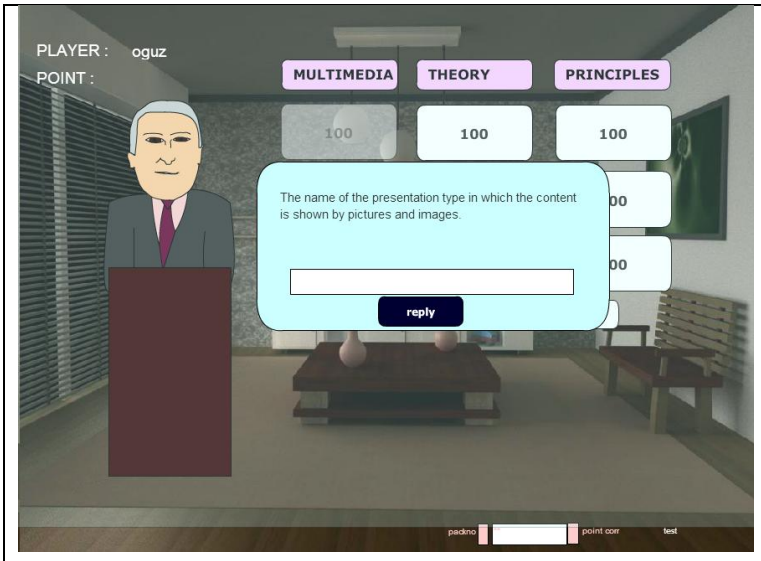
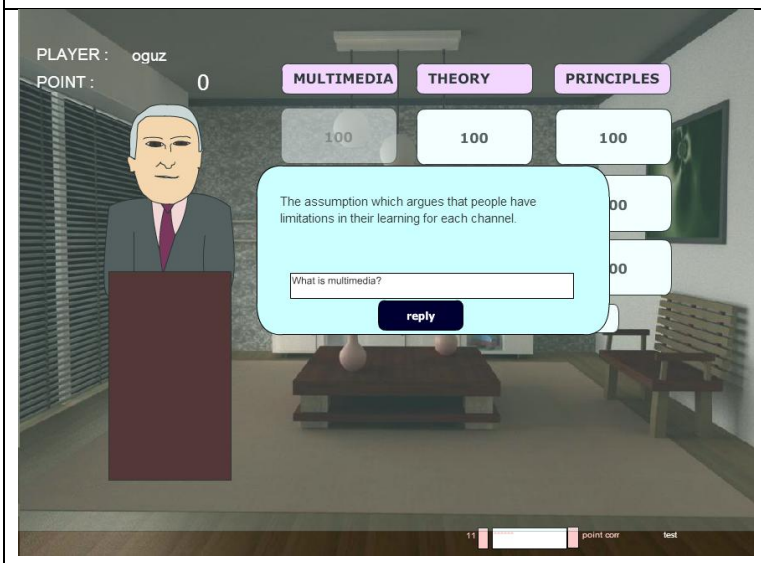
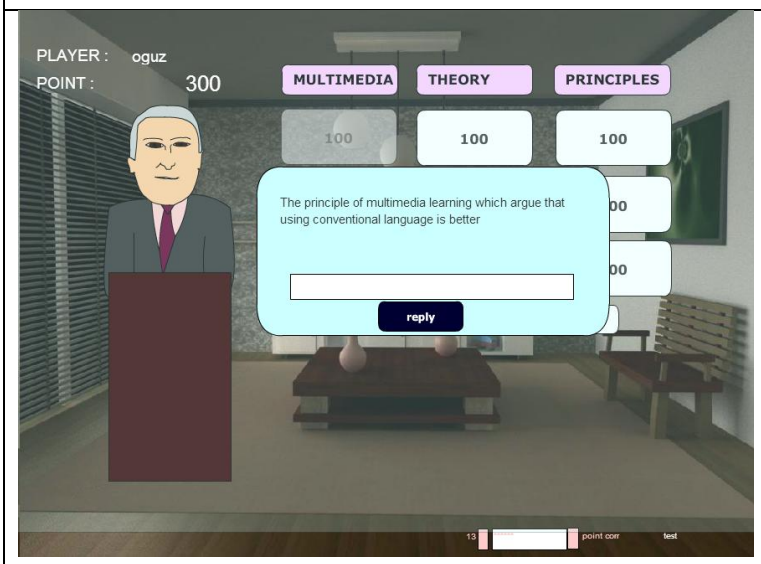
h. Eight question screen

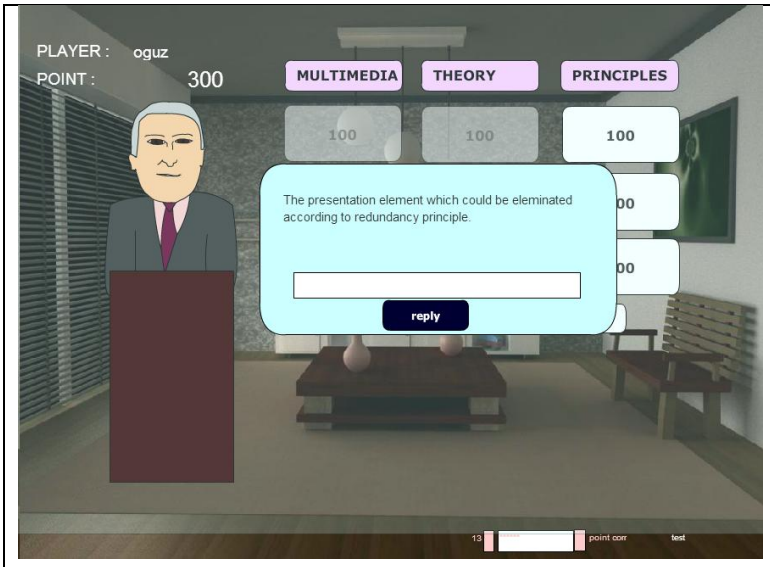
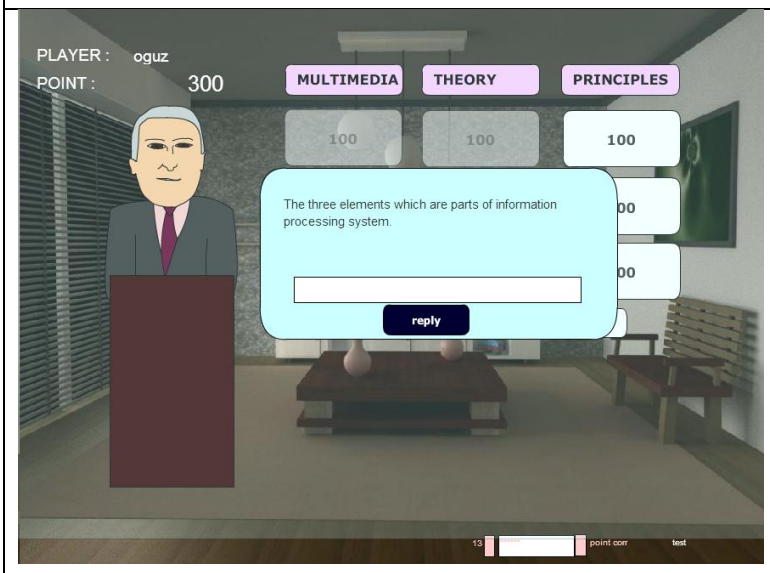
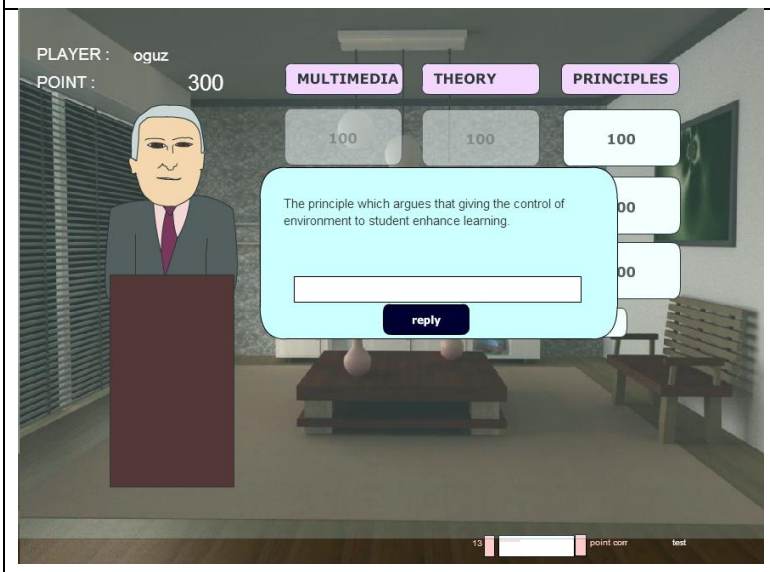
i. Ninth question screen

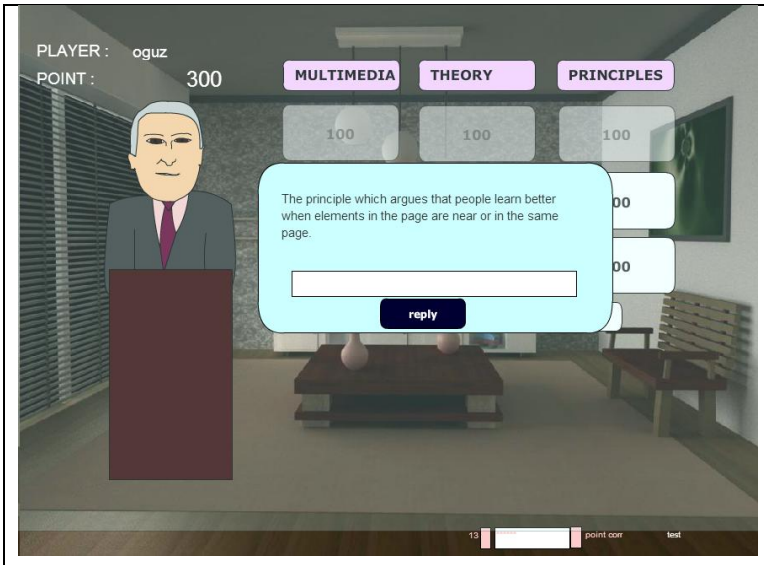
	j. Ninth question screen
	k. Eleventh question screen
	l. Twelfth question screen

	m. Thirteenth question screen
	n. Fourteenth question screen
	o.Fifteenth question screen

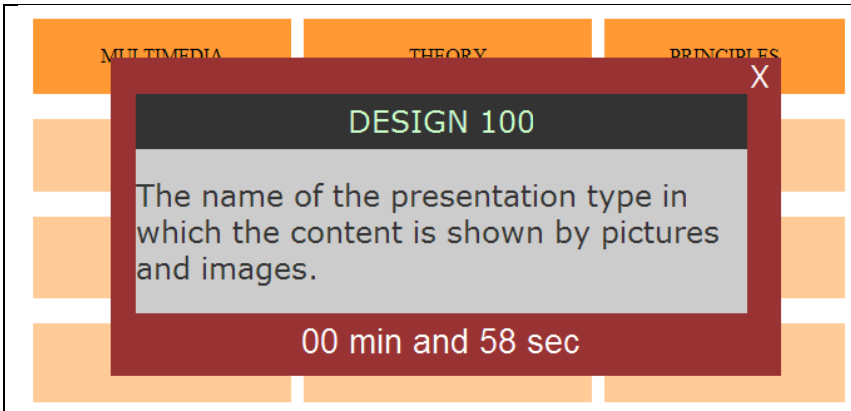
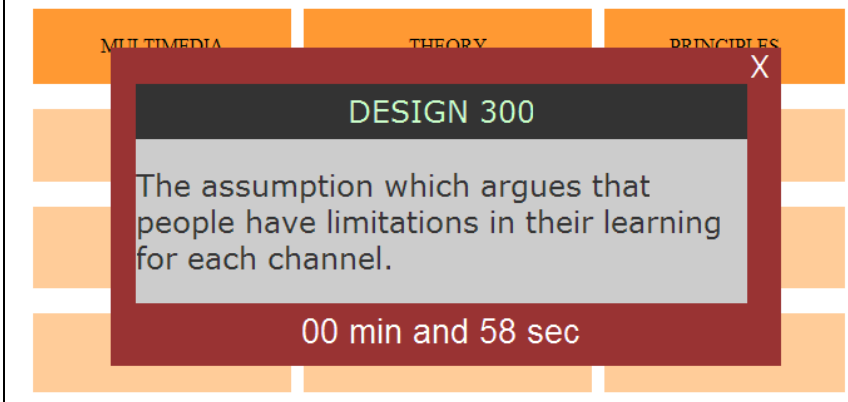
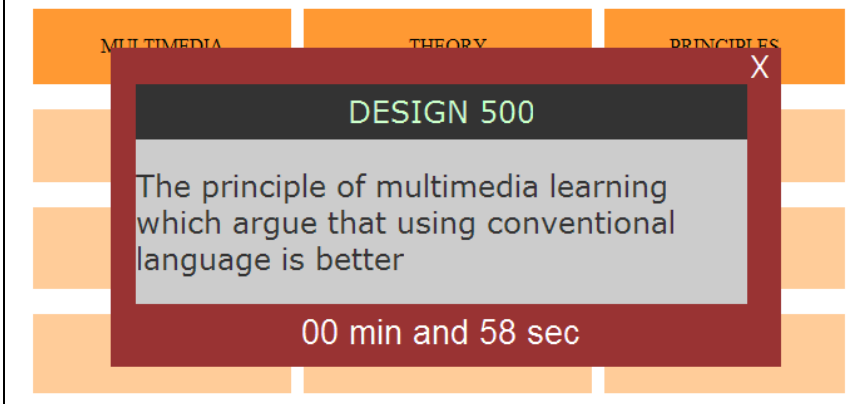
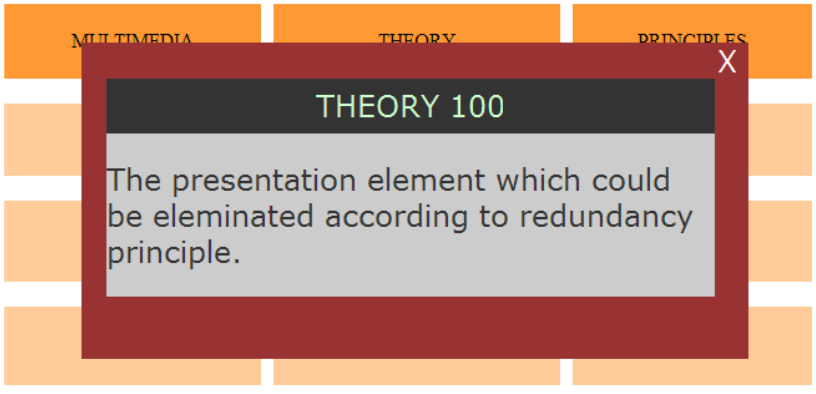
Appendix B: Screens of 2d Risk Game

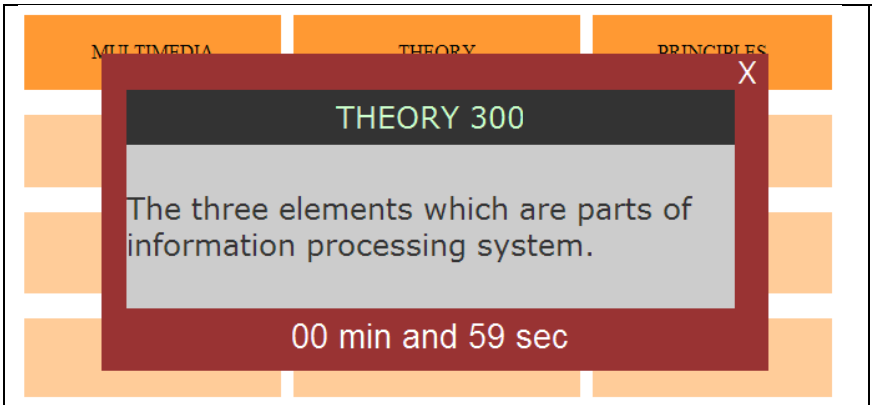
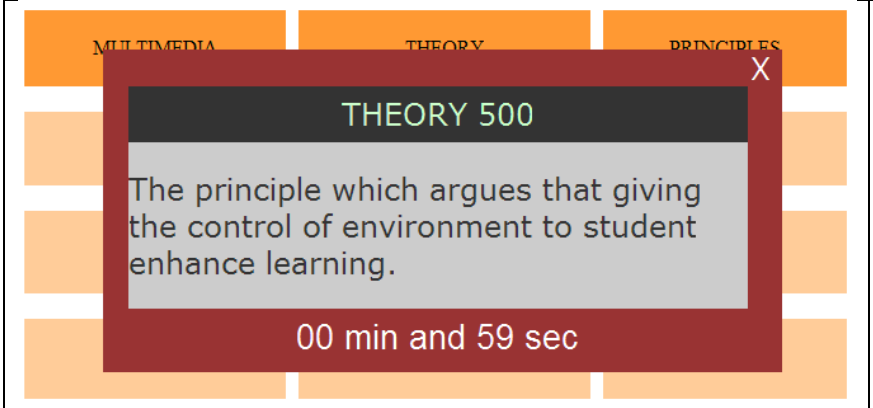
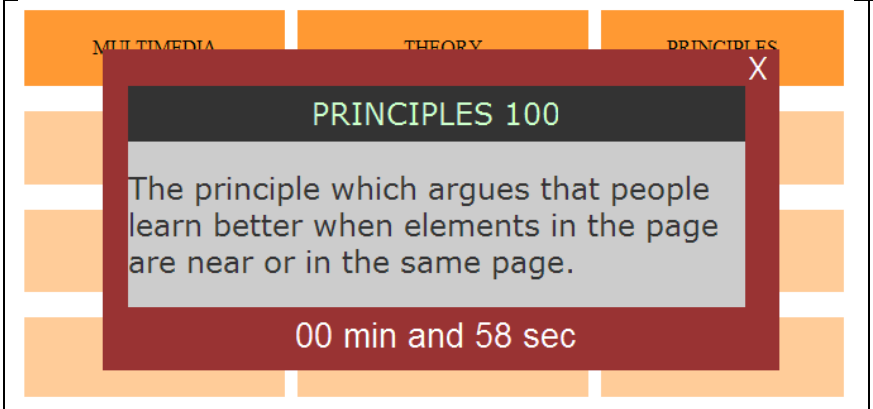
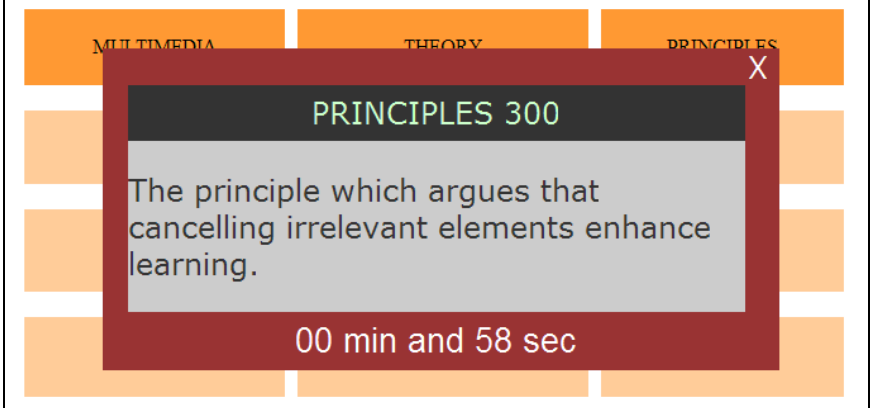
	a. First question
	b.Second question
	c. Third question

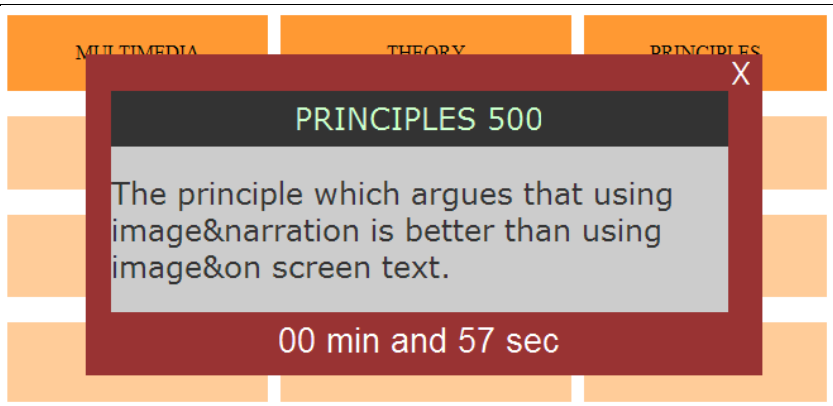
	d. Forth question
	e. Fifth question
	f. Sixth question

	g. Seventh question
	h.Eighth question
	i. Ninth question

Appendix C: Screens of 3d Risk Game

	a. Design 100 question
	b. Design 300 question
	c. Design 500 question
	d. Theory 100 question

	e. Theory 300 question
	f. Theory 500 question
	g. Principles 100 question
	h. Principles 300 question

	i. Principles 500 question

Appendix D: Student Information Form

Student Information Form

This form will take background information about you and your usage of technology. The information taken won't affect your grade and your private information will not be shared with anyone.

Please answer the following items by filling the empty areas.

Student ID : .....

GPA : .....

Date of birth : .....

Gender : ○ Female ○ Male

How many hours in average do you use computers in a day? .....

How many hours in average do you play games in a day? .....

What are the names of 3 games you played in the last 2 years?

(1) ..... (2) ..... (3) .....

Which of the following tools do you use and in what frequency?

Please select one of the 5 options for each items from the following list. The option you select will show the frequency of the corresponding item.

	Not use	Rarely	Moderately	Frequently	Always
Any type of computer (Desktop / notebook / netbook)					
Cell phone					
Smart phone or PDA					
Tablet computer or pad computer					
Internet connection					
Any social network platform (Facebook/twitter…)					
Any chatting platforms (ICQ, messenger, web chatting…)					
Email Account(s)					
Web blog(s) or website(s) (as a writer)					
Forum(s) (as a writer)					

Appendix E: Student Preferences about Learning Type Questionnaire

Student Preferences about Learning Type Questionnaire

- *Please select one of the 5 options for each item in the list. Options are changing 1 to 5; 1 means you strongly disagree with the corresponding item, 5 means you strongly agree with the corresponding item.*
- *Grade each item according to session that in which you have learned the learning unit of "Principles of Multimedia Design"*

#	ITEMS	1-Strongly	2-Disagree	3-Moderate	4-Agree	5-Strongly
1	I have learned about Mayer's "principles of multimedia design" learning unit					
2	I gave my attention to learning during the session					
3	This type of learning was challenging in an acceptable level for me					
4	This type of learning is enjoyable for me					
5	I missed some part of the learning unit during the session					
6	The session increased my knowledge of "principles of multimedia design"					
7	I think I could learn better if I take courses in this type of learning settings					
8	I was an active learner during the session					
9	This type of learning is boring for me					
10	I felt that I have control over my learning during the session					
11	Learning activities in the session was too difficult for me					
12	I temporarily forgot worries about everyday life					
13	I like the learning unit "Mayer's principles of multimedia design"					
14	I wanted the session to end					
15	I was stressful during the session					
16	I was aware of what was going on during the session					
17	I was confused about the aim of most of the learning activities in the session					
18	I received feedback on my progress in the session					
19	Learning activities in the session was too easy for me (deleted)					
20	I prefer to study my other courses within this type of learning setting					
21	I lost my attention in most of the session					
22	This type of learning was ineffective for me					
23	I felt that I am involved in the session					
24	It would be better if I study the same learning unit within different learning settings					
25	I forgot about time passing during the session					

THANKS FOR YOUR PARTICIPATION ☺

Appendix F. Pretest

Student ID: _____

Group: Face-to-face

PRETEST

(Mayer's Principles of Multimedia Design Learning Unit)

1. What is the name of the message if we present it by using both words and pictures?
   a. Media message
   b. Meta data message
   c. Data message
   d. Multimedia message

2. If a student learn a learning unit and apply what s/he learns than which type of learning is this? (Item 2 is removed)
   a. No learning
   b. Meaningful learning
   c. Rote learning
   d. Unmeaningful learning

3. Which one of the following is NOT an assumption of Cognitive Theory of Multimedia Design?
   a. Limited capacity
   b. Active – processing
   c. Selective perception
   d. Dual – channel

4. The assumption which says that "humans process separate channels for processing visual and auditory information" is called as;
   a. Dual – channel assumption
   b. Multimedia assumption
   c. Media based learning assumption
   d. Multi – channel assumption

5. Which of the following statement is the key point in limited capacity assumption?
   a. Humans learn better if the amount of information they process at a time is stable
   b. Amount of information that humans process in each channel at a time is limited
   c. Humans learn better if the amount of channels they use at time at least two
   d. Amount of information that humans process in each channel is fluctuating

6. If a student “attend relevant incoming information, organize selected information into coherent mental representation and integrate mental representations with other knowledge” this called as;
    a. Dual-channel assumption
    b. Multimedia based learning
    c. Active-processing assumption
    d. Constructivist learning

7. Which one of the following multimedia presentation conditions -in which students learn more deeply- identifies multimedia principle?
    a. The ones involving words and pictures than involving words alone
    b. The ones in which animation and narration are presented simultaneously rather than successively.
    c. The ones in which extraneous words, sounds, and video are excluded rather than included.
    d. The ones which are signaled rather than non-signaled

8. Which one of the following principles is belonging to the following definition? *“Students learn more deeply from multimedia presentation in which animation and narration are presented simultaneously rather than successively”*
    a. Coherence principle
    b. Multimedia principle
    c. Contiguity principle
    d. Redundancy principle

9. Which principle tells that “we should exclude extraneous words, sounds and video rather than included for deeper learning”?
    a. Modality principle
    b. Redundancy principle
    c. Personalization principle
    d. Coherence principle

10. Which one of the following suggestion is the heart of modality principle?
    a. In multimedia you should present animation and narration simultaneously
    b. In multimedia you should exclude extraneous words, sounds and video.
    c. In multimedia you should present animation and narration instead of animation, narration, and on-screen text.
    d. In multimedia you should present animation and narration instead of animation and on-screen text

11. Which principle argues that the usage of “animation and narration” more helpful than the usage of “animation, narration and on-screen text”?
    a. Personalization principle
    b. Modality principle
    c. Coherence principle
    d. Redundancy principle

12. Which principle argues that the usage of conversation style when presenting words result in deeper learning than usage of expository style?
    a. Interactivity principle
    b. Signaling principle
    c. Personalization principle
    d. Modality principle

13. Which one of the following facts identifies the interactivity principle?
    a. Using conversation style of communicating rather than expository
    b. Excluding extraneous words, sounds and video
    c. Presenting animation and narration simultaneously
    d. Giving the control the presentation rate of multimedia to students

14. Which one of the following principles explains that “students learn more deeply when multimedia explanations are signaled”?
    a. Personalization principle
    b. Signaling principle
    c. Interactivity principle
    d. Redundancy principle

Appendix G. Posttest

Student ID: _____

Group: Face-to-face

POSTTEST

(Mayer's Principles of Multimedia Design Learning Unit)

1. Which one of the following statements is the definition of Multimedia?
    1. The presentation of material for different devices
    2. **The presentation of material using both words and pictures.**
    3. A kind of video format which is used by different resources
    4. A kind of file format which is used by different resources.

2. If a student memorizes a learning unit than which type of learning is this? (Item 2 is removed)
    a. Meaningful learning
    b. No learning
    c. Unmeaningful learning
    d. Rote learning

3. Which one of the following is an assumption of Cognitive Theory of Multimedia Design?
    a. Experiential learning
    b. Limited capacity
    c. Cognitive load
    d. Selective perception

4. Which one of the following statements is the key point in dual channel assumption?
    a. Human's learning capacity is limited
    b. People learn better if you present material less than two channels
    c. People learn better if you present material by using at least two channels
    d. People have different channels for visual and auditory information

5. The assumption which says that "humans are limited in the amount of information that they process in each channel" is called as;
    a. **Limited capacity assumption**
    b. Cognitive load assumption
    c. Limited learning assumption
    d. Cognitive capacity assumption

6. Which one of the following statements is identifying active-processing assumption?
    a. Attending and organizing coming information into coherent mental representation
    b. Selecting and categorizing coming information according to perceptions
    c. Selecting and adopting coming information into active usage
    d. Attending and adopting coming information into active usage

7. Which one of the following principles is belonging to the following definition?
    "Students learn more deeply from multimedia presentations which involving words and pictures than from words alone"
    a. Multimedia principle
    b. Contiguity principle
    c. Coherence principle
    d. Redundancy principle

8. Which one of the following multimedia presentation condition -in which students learn better- identifies contiguity principle?
    a. The ones involving words and pictures than from words alone
    b. The ones in which extraneous words, sounds, and video are excluded rather than included.
    c. The ones which are signaled rather than non-signaled
    d. The ones in which animation and narration are presented simultaneously rather than successively.

9. Which one of the following suggestions is the heart of coherence principle?
    a. In multimedia you should exclude extraneous words, sounds and video.
    b. In multimedia you should present animation and narration simultaneously
    c. In multimedia you should give control of the presentation rete to students
    d. In multimedia you should signify the multimedia explanations

10. Which principle tells that "we should present animation and narration instead of animation and on-screen text"?
    a. Modality principle
    b. Redundancy principle
    c. Personalization principle
    d. Coherence principle

11. Which one of the following group of elements in multimedia presentation is better according to redundancy principle?
    a. animation and narration instead of animation, narration & on-screen text
    b. animation and on screen text instead of animation, narration & on-screen text
    c. narration and on screen text instead of animation, narration & on-screen text
    d. animation instead of animation and narration

12. Which one of the following presentation types is better according to personalization principle?
    a. Using academic style
    b. Using conversation style
    c. Using expository style
    d. Using presentation style

13. Which one of the following principle explains that "students learn better if you give them the control of the presentation rate of multimedia explanations"?
    a. Personalization principle
    b. Signaling principle
    c. Redundancy principle
    d. Interactivity principle

14. Which one of the following conditions defines the signaling principle?
    a. Giving the control of the presentation to the students
    b. Using conversation style of communicating
    c. Signaling multimedia explanations
    d. Presenting animation and narration simultaneously

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