ADAPTABILITY AND PLAYER MOTIVATION THROUGH CONTENT CUSTOMIZATION:
The impact of content customization in educational games.

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Abstract

Serious games can be used for a vast amount of different purposes and they change the way we think, learn, and entertain ourselves. The focus of this paper will be more about learning or educational games and how the adaptation of content through personalized preferences can be of an importance for capturing the user’s interest and retaining their motivation. The aim of this paper is to highlight the importance of the content adaptation of a serious game target group in order to maintain their motivation to achieve the learning outcome. The players of serious games usually have a goal or motivation prior to begin playing a game. Those goals may include the learning of a new language or increasing one’s geography or math skills. By adapting the content of a serious game to the level of knowledge of a player or giving the player the opportunity to choose in what field they would like to increase their knowledge in, could be a factor to maintain the player motivation up until the goal of the player is achieved. In this paper, an adaptive educational game has been developed to examine whether a target group with personalized content will indicate a higher motivation to play the game than another group which will be playing the direct version of the game without any personalized content.

Keywords: Educational games, Content Customization, Player Motivation, Gamification
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1 Introduction

Serious games are games with an aim that is not only entertainment. Over the last decade the importance of serious games has attracted a lot of attention. Serious games are now being used in several fields with different game objective in each case. A field in which serious games have a rapid development are the educational games. Educational games can and are being used in schools and businesses in order to help as tools in the facilitation of learning.

The players of serious games usually have a goal or motivation prior to begin playing a game. Those goals may include the learning of a new language or increasing one's knowledge on a specific topic or even a language. Defining the goals and motivations of the players of a serious game are factors important for the development of a serious game. If the goal and the target group of a serious game is clearly defined the proper development of the game will be easier and more possible to keep the motivation of the player up to a level that will lead to higher retention which could possible lead to successful learning.

The clear definition of the target group and its goals will assist in the development of an adaptive serious game that will meet the expectation of each target group. By neglecting to consider who will play this game and why they will play it, the development of a serious game can be decreasing the motivation for its players, since they do not see themselves accomplishing they’re prior to the game goal nor been asked what that was. Kickmeier et all (2011), argued that one of the most crucial factors for successful educational games can be seen in the game’s ability to maintain an individual learner’s motivation and interest by adapting the individual learning and gaming experiencing the this very learner’s needs, preferences, goals, and abilities.

This paper reviews and provides a brief analysis for the motivational factors in serious games and more specifically in the gamification of learning and the importance of personalized content. Research indicate that the process to increase a player’s motivation, is by gamifying their learning environment in an adaptive way (Monterrat et al., 2017). Thus, the customization factor which leads to personalization must be examined in isolation and see whether the results are positive, neutral or negative. The learning aspect of serious games must be well motivated through various gamification methods for increasing the motivation to learn while playing with different
kind of mindset. The essential part is to offer the players a choice that will allow them to achieve their desired goal prior to playing the game and therefore maintaining the players motivation.

To examine what is the impact of customization of the content in an educational game on the players motivation, an adaptive educational game has been developed. The game was developed to examine whether a target group with personalized content will indicate a higher motivation to play the game in comparison to another group which will be testing the direct version of the game without any personalized content.
2 Background

A plethora of research is trying to analyse why some serious games are more successful in terms of learning outcome compared to others. Ravyse et al (2017) argues that the most important factor for a serious game to offer a successful learning is for the game to be fun, since if the serious game is fun to play the motivation to play the game will remain and the learning outcome will be easier to achieve. Nevertheless, in serious games the challenge is to keep the user motivated to keep playing, since a motivated learner cannot be stopped (Prensky, 2001).

Serious games have been used to increase the effectiveness of the learning process since the entertaining nature of games motivates the user to learn (Hirdes et al, 2014). In a serious game the learning objectives are integrated into the game (Hirdes et al, 2017). Teachers have concluded that serious games should be used in learning contexts to engage students (Riemer & Schrader, 2015). In addition, research has shown that educational games increase the student’s motivation and learning retention (Divjak & Tomic, 2011).

In some cases, defining the motivation of a player may be straightforward, for instance educational games are widely being used in business, where the motivation and goal of the user is to be trained on a specific task (Allam & Sutton, 2017). According to Ryan & Deci (2000) “to be motivated means to be moved to do something”. Prensky (2001) argues that the main motivation to participate in online games in general, is the learning achieved by playing a game. The learning outcome could be on the surface how to do several things such driving fast cars and fighting. However, the learning can involve a deeper level of learning such as making quick decision and taking in information from different sources. Therefore, in educational games getting user engaged seem to be easier.

According to Kickmeier et all (2011), one of the most crucial factors for successful educational games can be seen in the game’s ability to maintain an individual learner’s motivation and interest by adapting the individual learning and gaming experiencing the this very learner’s needs, preferences, goals, and abilities. As mentioned, Ravyse et al (2017) concluded that the most important factor for a serious game to offer a successful learning is for the game to be fun, since if the serious game is fun to play the motivation to play the game will remain and the learning
outcome will be easier to achieve. Monterrat et al (2017), argued that the process to increase a player’s motivation, is by gamifying their learning environment in an adaptive way. Monterrat et al (2017) examined the effect of gamifying features of an existing learning game in an adaptive way on motivation. The results of their research were inconclusive as their experiment did not clearly demonstrate the benefits of adaptive gamification on gamer’s motivation. Monterrat et al (2017) however argued that the gamification and adaptability of a game significantly affects the player motivations.

2.1 Motivation

According to Ryan & Deci (2000) “to be motivated means to be moved to do something”. Prensky (2001) argues that the main motivation to participate in online games in general, is the learning achieved by playing a game. The learning outcome could be on the surface how to do several things such driving fast cars and fighting. However, the learning can involve a deeper level of learning such as making quick decision and taking in information from different sources. Therefore, in educational games getting user engaged seem to be easier.

Motivation is nevertheless easy to define. Ryan & Deci (2000) argued that the motivation may vary in terms of amounts, but also as to what kind of motivation a person may have. They distinguish the motivation based on the reasons or goals that give rise to an action. The two main categories of motivation according to them are intrinsic and extrinsic motivation. Intrinsic motivation refers to the motivation of doing something because it is inherently interesting or enjoyable. Extrinsic motivation on the other hand, refers to the motivation of doing something because it will lead to a separable outcome.

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2.2 Digital Game Based Learning - DGBL

Based on the projected primary learning outcomes, three types of Digital Game Based Learning can be distinguished aiming at knowledge transfer (cognitive learning outcomes), skill acquisition (skill-based learning outcomes) or attitudinal/behavioural change (affective learning outcomes), Al et.all (2013). Primary learning outcomes can entail certain secondary learning outcomes (e.g., a game that aims at teaching math skills can also lead to a more positive attitude towards math). Roach (2003) claims that the main pedagogical criterion qualifying a computer game should be content understood by a child. Furthermore, a game must have a social, cultural and educational potential in accordance with the existing educational frames within the society directed at technology.

Papastergiou (2009) conducted a research in a secondary school on a sample of 88 pupils, 47 in group A who used computer games in learning, and 41 in control group B without computer games. The research analysis indicated that teaching with computer games was more efficient in promoting pupils’ knowledge, i.e. these pupils were more motivated for work when compared to teaching without computer games. The results suggested that learning with computer games resulted in better motivation and knowledge.

Digital game-based learning systems must consider the heterogeneity of the users and their varying knowledge levels, cultural backgrounds, usage surroundings, skills, etc. The effectiveness of DGBL as an instructional medium firstly consists of first order learning effects, referring to a direct influence on knowledge, skills, attitudes or behaviour.

2.3 PERSONALIZING LEARNING AND GAMING

Generally, the idea of personalized learning comes from the field of adaptive/intelligent tutoring in conventional technology-supported teaching and learning, basically inspired by Benjamin Bloom in 1984 who stated that students who received one-to-one tutoring performed on average as well as the top two percent of those receiving classroom instructions. Ever since psychologists, instructors, and technicians attempted to develop technology that is able to take the role of a private teacher and to intelligently provide individual learners with suitable tutoring. The spectrum of approaches, methods, frameworks, and applications is quite broad (De
Bra, 2008; Kinshuk, Lin, & Patel, (2006). In their study Kickmeier Rust et all (2011), they describe Adaptivity as a term that refers to three major concepts: (a) Adaptive presentation, which means adjusting the look and feel of a learning environment according to individual preferences or needs; for example, different colour schemes, layouts, or amount of functionality; (b) adaptive curriculum sequencing, which means providing the learner with learning tailored to individual preferences, goals, learning styles, or prior knowledge; (c) adaptive problem solving support, which means providing the learner with feedback, hints, or solutions in the course of problem solving processes. Based on these three major concepts of adaptivity this paper was inspired to see the effects only of the adaptive curriculum sequencing aspect and that is the reason that this research has as focus the minimal content customization which will serve the feature of giving customized content to individual preferences and learning goals.

The personalized games are being used more and more as technology advances. Bakkes et al (2012) defined a personalized game as a game where player models are used with the aim of tailoring the game experience to the individual player. Monterrat et al (2017) argued that an adaptive learning environment is affecting motivation. They proposed a generic model and process by which a learner’s motivations could be increased by gamifying the learning environment in an adaptive way.

2.4 Content Personalization vs Content Customization

Content Personalization is a term mainly used in web development for referring to the strategy that relies on visitor data to deliver relevant content based on audience interests and motivations. In comparison to the term personalized games which are games that can adapt to the player’s needs, performance and goals. Moreover, Streicher and Smeddnick (2016) argue that in predefined, static (software) systems, an extensive adaptation to individual user potentials and needs is typically not possible, because these systems can only act within their predefined limits. Therefore, when talking about personalized and adaptive games, one often thinks of games which can adapt – or be adapted - beyond a limited set of predefined settings through an intelligently acting engine.
On the other hand, individuals have different preferences, so they may show different reactions to such game elements. Thus, there is a need to provide individualization. Individualization can be achieved by personalization and customization. The former uses adaptivity to tailor content, structure and present to each individual automatically while the latter provides adaptability for individuals to modify the content presentation, format layouts, and navigation facilities by themselves (Treiblmaier et al., 2004). These two approaches have been widely used in educational settings. Regarding personalization, Lin, Yeh, Hung, and Chang (2013) developed a personalized creativity learning system that provided personalized learning paths for optimizing the performance of creativity. Their result showed that personalized learning paths were useful to improve students’ creativity scores. Besides, they revealed that integrating personalized learning and GBL into a creative learning program could improve learners' motivation and learning effects. Regarding customization, Burkolter, Weyers, Kluge, and Luther (2014) investigated how a customized user interface reduced errors and enhanced user acceptance. Their results showed that students with the customized user interface demonstrated significantly lower error rates and higher acceptance than those with the default user interface.

However, Streicher and Smeddnick (2016) argue that for learning games this is usually not the case, because everyone tends to learn differently. In the real world, one-to-one tutoring or well-guided group learning that respect the heterogeneous properties of groups of learners and individual learners can arguably produce the best educational outcomes. Thus, targeting to replicate the customization and personalization present in these antitype scenarios in the development of serious games appears a reasonable pursuit. Ku et al (2016) also consider that more research needs to be conducted on this issue as they state that, there is a lack of studies to use personalization and customization to develop GBL systems that accommodate the preferences of the Holists and Serialists. In short, they review what Holists and Serialists perspectives are and while Holists have a more personalized way of thinking, in a manner of adapting to performance, preferences and historical data, the Serialist perspective involves simpler thinking and is more direct to specific task. Holists favoured to use links to discover the relationships between topics while Serialists preferred to use an index to find a route for a specific task.
A similar result was obtained from Jorritsma, et. all (2015), which showed that the customization support made participants work more efficiently. Furthermore, Kleinsmith and Gillies (2013) presented a sport game in which players could customize the behaviour of their characters with their own movements while playing the game. The results of their study discovered that using their own movements made the users feel more engaged with the game and the design process, due to the sense of personal ownership of the movement. The aforementioned studies suggest that customization and personalization bring different benefits to student learning.
3 Problem

In a serious game the learning objectives are integrated into the game (Hirdes et al, 2017). Teachers have concluded that serious games should be used in learning contexts to engage students (Riemer & Schrader, 2015). However, as we know, the motivation to keep playing the game until the educational purpose is achieved is not guaranteed. A plethora of research is trying to analyse why some serious games are more successful in terms of learning outcome compared to others. Ravyse et al (2017) performed a literature review to determine the factors that makes learning with serious games successful. They concluded that the most important factor for a serious game to offer a successful learning is for the game to be fun, since if the serious game is fun to play the motivation to play the game will remain and the learning outcome will be easier to achieve. More specifically, Kickmeier et all (2011) have stated that future work will not only strengthen the experimental foundations of educational games, important aspects of assessment and adaptation.

Therefore, the inspiration for this research has been mostly Kickmeier et. all (2011) research which they examine micro and macro level interventions on adaptive game-based learning and their effects on users’ motivation. However, it is also inspired from the research of Ku et all (2016) which they also analysed the two perspectives of Holists and Serialists for viewing this matter of content customization and personalization and the impact of the content to be customized and adapted to the players desires for maintaining their learning motivation. By performing a brief literature review on serious games motivation and developing this content customizable educational game, I aim to examine the impact of minimum content customization in an educational game, on the players motivation. Monterrat et al (2017) who examined the effect of gamifying features in an adaptive way on motivation, claimed that their results were inconclusive since they were based on the perception reported by the users, and suggested that further studies are needed to evaluate the real impact on engagement and learning. Monterrat et al (2017) however argued that little is known on how adaptation of gaming features can be applied on computer-based environments and that further research is required. Moreover, the research question that will guide this paper is:
What is the impact of content customization in an educational game on the player's learning motivation?

Therefore, this article aims at examining the effects of minimum content customization in an educational game on whether they will be increasing or decreasing or having neutral impact on the learners' motivation, by gamifying their learning environment in an adaptive but customized way. The following model allows selection of content in an educational game so that we can see the difference between that group and another control group which will not have any customization and they will play the game with equally distributed chances among the content. The customization content process has been implemented in an existing learning quiz about Math, Geometry and Physics, named Trikat-Quiz, which aims to allow students of the third class of gymnasium to have a review session with an interactive quiz.

3.1 Previous Research

As mentioned by Ku et all (2016) and Kickmeier et all (2011) further research needs to be conducted on the scenarios of adaptation to the user’s preferences and goals, however there is also the need to study the impact of each feature separately so that the relative importance can be shown. Games have been used to increase the effectiveness of the learning process since the entertaining nature of games motivates the user to learn (Hirdes et al, 2017).

In some cases, defining the motivation of a player may be straightforward, for instance educational games are widely being used in business, where the motivation and goal of the user is to be trained on a specific task (Allam & Sutton, 2017).

The effects of adaptable game features to enhance the learning procedure was examined by Monerrat et al (2017) p.15 the results were:” We expected learners with a gaming feature matching their player profile to perceive this feature as more fun and more useful than learners with a randomly selected or a counter-adaptive feature. However, the results show that learners with counter-adaptive features rated them as more fun and more useful.” Which indicates further research needs to be done on their adaptable model and what are the impacts of it. Research has indicated a plethora of benefits of the educational games through personalized content and learning (Bakkes et al.,2012).
However, the focus has been mostly on the adaptation of personalized games and systems. There are not a lot of research on the customization of learning content based on the user's preferences, Ku at all (2016) Therefore, the aim of this study is to further examine and isolate the feature of customization of the content to be learned, so that the learning motivation of the players can be examined in comparison to a control group. This research aims to contribute by conducting a research on content customization and then isolating this feature into an educational game, by having the content which will be selected from the user with higher frequency than the rest of the content. This will be achieved with a specific pattern/algorithm that will be increasing the frequency of the content which was selected so that the user, will be examined in that content category the most, which he was most motivated for. Further details about the game which was developed, will be explained further on.
4 Methodology

To examine the effect of content customization in educational games and its effect on players motivation, an educational game has been developed to isolate the feature of content customization. In order to isolate the feature of content customization the approach is to have two versions of the game one that will have equally distributed chances among the categories of the questions and one that will have 48% chance of the selected category so that the frequency of that selection will be occurring more often. The game was developed specifically for students in the third class of gymnasium of school in Greece, for them to review their curriculum in Math, Physics and Geometry. The study was chosen to be performed on students since it is easier to define their knowledge level and examine the effect on motivation as it is a homogenous group. Ravyse et al (2017) highlighted the importance of having a homogeneous target group before the production of the game to develop a serious game that is fun to play. Therefore, this research will have better results the knowledge base skills of the participants must be on averagely the same levels.

Therefore, the initial step was the communication with the school’s principal, so that the permission can be acquired, and the game can be developed based on the knowledge level of the student in the 9th grade in mathematics, physics and geometry, by the curriculum they have been taught by their teachers. Then also inform the teachers of that class about the research and how they can help by providing questions on the material that the curriculum includes. The type of this serious game will be a Quiz (questionnaire) with four multiple choices out of which only one is correct, as highlighted by Riemer & Schrader (2015), what type of serious game is used in an experiment can affect the results. The quiz form was chosen since it is a game genre that is easy to develop and does not have any limitations in terms of user group or subject of examination (Hung et al., 2014).

In second phase the development of the Trikat-Quiz had started which, would consist of these two versions for two groups of students. With a sample of questions drawn by me from schoolbook’s text material on the target subject classes. This occurred with the consideration that these should questions should be replaced the ones that the teachers will assign, since those questions will be what they have been taught from their teachers.
4.1 The Trikat-Quiz

The starting screen of the game which was developed for this research experiment can be seen in Figure 2. This is just so for aesthetics reasons and so that when the students open the game they can have a starting screen to memorize and connect with for this game. Additionally, in Figure 3, you can see the customization question for the one version of the game which would have the feature to customize the content to be reviewed the most. In Figures 4 & 5 there are two examples of questions and how the structure of the Quiz has been formed. It does not matter what version the participant would play the quiz would look exactly the same. So that there is not this factor to consider as well, since if the two versions were also aesthetically different that would probably have some impact on the participants motivation, thus making the results incomparable. There is always a risk that the elements in a game will motivate more some learners and also have a negative effect on other learners (Monterrat et al., 2017). The design of the questionnaire is simple with a few feature since the increasing number of gaming features increases the complexity and research suggest few and simple gaming features (Monterrat et al., 2017). Therefore, only the essential feature such as question, control buttons etc were used in the development of the game.

Both versions of the game, will have the same pool of questions to draw and give to the player after each response or when they skip a question. The only and very important difference that the two versions have, is that the Direct Quiz version has a randomizing chance between each of the category questions to 33.3% whereas the other version with the Customized Content Quiz has the focus category on 48% and the others at 26%. This is the mechanism that we are essentially examining the impact of it, on the motivation of the user to play this educational reviewing game.

The game will have as main features of intrinsic values the time and the score however what we care for, is the time. The score is just an indicator for the student to somewhat understand better their level of knowledge in the specific courses. For each question in the quiz the players have available 4 minutes to answer and for each correct answer they get +25 points whereas for each wrong answer they get -10 points. They can also skip the questions for +0 points. This mechanism allows their time to be more valuable and directed for each question that they want to answer, since they can always skip without any negative impact on their score.
Furthermore, every time the players view ten questions the game will pop up a window to ask them if they want to continue or not, which is just a reminder that they can stop anytime they want. This serves as a control variable as well since those that want to continue are usually those that are more motivated with the task. In addition, the game will count how many questions each user has viewed, skipped and how much total time they spent on the game and will calculate the average time to respond variable, ATR, which will be accounted for their average relative interest for the game (Kickmeier et. al., 2011).

4.2 The IMI Questionnaire

As for the instrument that has been chosen to evaluate the participants subjective experience it is a multidimensional measurement device that is called Intrinsic Motivation Inventory (IMI). The example that I will use is a 22-item version of 7th Likert scale that has been used in several lab studies on intrinsic motivation Prensky (2001). The specific example which I will use for this research is called Task Evaluation Questionnaire (Figure 1) and is being used to measure these four subscales: interest/enjoyment, perceived choice, perceived competence, and pressure/tension.

The interest/enjoyment subscale is considered the self-report measure of intrinsic motivation; perceived choice and perceived competence are theorized to be positive predictors of both self-report and behavioural measures of intrinsic motivation. Pressure tension is theorized to be a negative predictor of intrinsic motivation. Scoring information is presented in the Appendix A. The IMI subscale that we are chasing after is the interest/enjoyment which is considered the self-report measure of intrinsic motivation. The most important one and the one that a data analysis will be performed at is the interest/enjoyment of the players after they play the serious game. The IMI items have often been modified slightly to fit specific activities and experiments, however for this experiment the example of the IMI Task Evaluation Questionnaire (Figure 1) has been used as it is already a very good choice for the needs of this experiment.

As for the collection of the data, it will occur after the participants play the game from inside the application as it has been added to the post game section of the quiz. There the players have the choice to rank the questions of the IMI and in addition there
are two open questions in the end for them to answer, if they want, to add anything that was in their mind without necessary saying it to another person, so that they can be honest. These open questions can be observed in Figures 8 & 9 (page 24) and it is important to have under consideration that these are not part of the IMI and they have been added to replace the intention of a short interview with some participants but due to time limits that would not be possible, so these two open questions were included after the IMI questionnaire. All these questions of the Task Evaluation Questionnaire and the Open Questions had to be translated to Greek in order for the students to fully understand with no language barriers the IMI questions (items) for more valuable results.

**Figure 1 – IMI Task Evaluation Questionnaire**

3. I felt that it was my choice to do the task.
4. I think I am pretty good at this task.
5. I found the task very interesting.
6. I felt tense while doing the task.
7. I think I did pretty well at this activity, compared to other students.
8. Doing the task was fun.
9. I felt relaxed while doing the task.
10. I enjoyed doing the task very much.
11. I didn’t really have a choice about doing the task.
12. I am satisfied with my performance at this task.
13. I was anxious while doing the task.
14. I thought the task was very boring.
15. I felt like I was doing what I wanted to do while I was working on the task.
16. I felt pretty skilled at this task.
17. I thought the task was very interesting.
18. I felt pressured while doing the task.
19. I felt like I had to do the task.
20. I would describe the task as very enjoyable.
21. I did the task because I had no choice.
22. After working at this task for awhile, I felt pretty competent.

In the third phase, a sample of the questions for each category of the Quiz were received in the Greek language by the teachers of each course based on the student knowledge level (See Appendix D, E, F). Those subjects of Math, Geometry and Physics were chosen, as they are the most international subjects taught in schools
and would not limit the effect of the research based on the student’s location on the subjects. For this experiment, since we deal with Greek students, everything must be adjusted to the Greek language, such as the consent information, instructions of the game as well as the questions of the game and the post-game questionnaire which will occur after they play the Quiz so that we can have an indication of how the students reacted and what were there interest levels towards this activity. Therefore, in game statistics like the users’ Score, Total Time Played, Average Time to Respond, as well as Viewed Questions and Skipped Questions will be recorded so that they will serve as support variables in the observation of this research experiment. In addition, the post-game Questionnaire which will be from the Intrinsic Motivation Inventory of Prensky (2001) and will assist on indicating the the intrinsic motivation of the students so that they can be compared to a control group which will play a version of the game which will have no customization of the content feature, and so that will be the Direct Quiz group, whereas the other one will be the Customized Content group. Alongside with these numeric in game data and the scores of the post-game questionnaire, there will also be two open questions in the end of the questionnaire that state:

1) Is there something that you would like to comment more based on were your feelings towards this experience with the Trikat-Quiz?

2) Is there something that you would suggest for improving the Trikat-Quiz?

These two open questions will not be in the focus of the analysis however, with these there is also an aspect of the research which becomes more qualitative and is just something that will be considered only if there is a strong indication from the majority of participants about something in specific for the research experiment.

Despite the fact that we have two open questions as well in this approach, this is more of a quantitative research design and has been chosen due to the increased external reliability and the ability to generalize the results to the population (Bryman & Bell, 2007). In addition, by applying a quantitative research method a more macro perspective to the effect of content customization on motivation will emerge. Qualitative research may had offered a better contextual understanding of the effect of content customization yet, qualitative research is too subjective and is more difficult to replicate and generalize the results (Bryman & Bell, 2007). In addition, a qualitative research would offer better insight to what affect the content adaptability has, it would still be on a more micro perspective of the issue. Since the goal of this thesis is to
offer a more macro perspective and understanding of the content customization on a quantitative research method was chosen.

### 4.3 Ethical Considerations

However before moving any further, it is important to take under consideration the parental consent of the students to participate in this experiment, as well as their own consent since it is optional, and the research is measuring the motivation towards customized game-based learning. In order to get the parental consent, the school’s principal assisted for the parental consent of the students. We composed an email sending off to all the parents of the two classes of the third gymnasium so that they can be informed about the research and its purpose, see Appendix G & H. In addition, they were informed that this is also optional to the student and how the study focuses on allowing the students to stop participating at the research experiment at any given time as well as and that there is no sensitive data that will be held or processed., Next step, was to await for the principal confirmation that he received the parental consent for all the students, which happened within a few days and with no students to be excluded from the research due to parental consent. This essentially allowed the research to move further and have the game been tested as well so that crucial parts of it can be examined. Whether firstly if they are working properly and secondly if they could be improved before the real experiment takes place.

### 4.4 Pilot Test

The first pilot test was held with three university students and the aim of this test was to test mostly the technical parts of the game, which include:

1) The functionality in different kind of computers.
2) The functionality of the customized content feature (48 %, 26 %, 26%).
3) The functionality of recording the data that are needed after each play session. (Score, ATR, TTP, Viewed Questions, Skipped Questions, Intention to Continue and post-game Questionnaire)

The results were extracted to a txt file and were analysed so that the verification of the correct data can occur and see whether there were any flaws on those functionalities. As it was verified also by the participants the data that they saw that the game had
recorded were accurate and therefore it was verified that the functionalities are indeed working properly.

The second pilot test was performed on a sample of four middle school students were the purpose was to get insight on how they experienced the game and ensure that there would not be any technical issues. At this stage, a sample of three questions from each category were received from the students' teachers in the field of geometry, mathematics and physics. The two students played the game where there was the content customization feature and the other two played the other version in which there were equally random distributed questions from each category and then were introduced to a printed version of two questionnaires. One is the Task Evaluation Questionnaire from the Intrinsic Motivation Inventory of Prensky (2001) and the other is the Game Experience Questionnaire from IJsselsteijn et al (2013).

Both questionnaires measure efficiently with subscales that are accessing intrinsic motivational values for more detailed analysis and while they have slight a different focus both have the purpose of measuring the interest/enjoyment subscale from the users towards the activity, which is the most important for this research and its aspect toward the motivation of the users in an educational game. In addition to the fact that the IMI Task Evaluation questionnaire is a slightly shorter and with a higher Likert Scale than the GEQ and therefore it is more suitable for a broader spectrum of results while it will also maintain the time for the completion of the questionnaire in relative low scales. However, this phase of the pilot test was focused on finding what is more suitable, so further examination need to be done on what questionnaire should be kept changed or removed.

The focus was mainly to enhance the psychometric instruments of the evaluation of the game experience of each player and their motivation towards the game. At this point it has also been discussed with a teacher from the school about what will be used for measuring these psychometric phenomena, and these are the two mentioned and validated instruments:

1) The IMI questionnaire, Task Evaluation Questionnaire
2) The GEQ questionnaire, Game Engagement Questionnaire

These questionnaires are to be examined for this target group and how suitable they are. As the questions are approximately 37 questions in total and they are to the limit of being too many. The questionnaires were given to the four students in printed
format and translated into Greek to be filled out. They were also kindly asked to state which seemed to be harder to understand as well as to express their preference towards the questionnaires. It was also a big consideration of this research on whether another combination of post-game questionnaire could have been used. However, after consideration of the purposes and the common base of these two questionnaires, it was decided to keep one of them. Based on the time limitation that we would have since we occupy school students from their classes it is also important to always have that in mind as well. Therefore, the IMI of Task Evaluation Questionnaire seemed to be a more suitable choice. The additional input received in phase 2 from these students was that the IMI and GEQ questions should be in their native language rather than in English since it was in some cases possible for misinterpretation to occur, and that they were too many. After consideration, two decisions were taken, firstly to translate the questions in Greek, and secondly to keep only the IMI questionnaire of Task Evaluation, for the following reasons:

1) Translation of Questionnaire to Greek is more accurate for the IMI rather than the GEQ. Without the translation the questionnaire’s understanding from the students will be facing a barrier with the English language as it is no their native language.

2) IMI more suitable than GEQ because:
   - Shorter number of questions.
   - Higher Likert Scale which is equal to broader spectrum of results.
   - The Subscales of the IMI (Interest/Enjoyment, Perceived Competence, Perceived Choice and Pressure/Tension) are more accurate to the purpose of this experiment which is measuring the motivation of the players while learning on an isolated educational environment with – or without the feature of content customization.

Yet, it is a factor that will be taken into consideration during the examinations of the results, especially for the post-game questionnaire. If there was more available time for the participants, it might have been more useful to use a secondary questionnaire as well to support the IMI questionnaire, however since that would require translation to Greek as well which is the major drawback for this experiment.
4.5 The Sample

The participants for this experiment, as also mentioned before, were students from the same school in the same age of 14-15 but from two different classes of the third grade of gymnasium. One group of 17 students from one class had to play first the Direct Quiz version of the game and then the other group of 20 students from the other class had to play the Personalized/Customizable Content version of the game. However, the lab at the school had a limited number of available computers (10) so we had to break up the two groups to four groups. The first group of 17 people played the first two hours in two periods of one hour each. The second group of 20 people played after them another two hours in two periods of one hour each. They were informed that they have one hour available to play the game, but they could of course choose not to play it at all or quit at any time. All the groups came exactly when the classes were starting (ring of the bell) so one important thing to keep in consideration is that each hour the students had a different lesson that they were been occupied away from, due to this experiment. This might have impact on a very few number of students that wanted to participate in the experiment and did not because they had of course the choice not to and they preferred to stay in the class. Thus, most of the students that came thought and had in mind that they will lose some time from their class lecture. However, the teachers were fully informed, and they were the ones with the coordination of the principal to allow the children to go to the labs for this experiment. In addition, the students were informed that they will not be graded, and no one will judge them on their performance, and that this is a good review just for them to know where they are standing on the current required knowledge level of the courses and whether if they need to do some more review.
Figure 2 – Starting Screen

Figure 3 – Customization Question
In what course would you like to be focusing more?

Σε ποιό μάθημα θα θέλατε να εξεταστείτε περισσότερο;

[Buttons: Φυσική, Άλγεβρα, Γεωμετρία]
**Figure 4 – In game picture. (physics question)**

**Figure 5 – In game picture. (math question)**
**Figure 6 – Consent Information**

If you would like not to participate on this activity for any reason, you do have the right to do so. If also you would like to stop in the middle of your activity with the Quiz it is also acceptable.

**Figure 7 – Instructions**

You can play as much as you would like to. With every correct answer you will get +25 points and with each wrong answer -10. You can also Skip for +0 points. You have 4 minutes for each question.
**Figure 8 – Open Question 1**

Is there anything that you would like to comment about your feelings towards your experience with the Quiz?

**Figure 9 – Open Question 2**

Is there anything that you would like to suggest for improving the Quiz?
5 Analysis

For the evaluation of the data (Appendix B & C) that the gaming sessions have collected after the experiment, I have grouped up some data to expose the results first and then perform a more detailed analysis to what is most important for this research. They can be observed in Figures 10 & 11. We will essentially compare the averages of how well the Direct Quiz group performed in comparison to the Customized Content Group by the data produced by the game as well as their IMI questionnaire results.

Figure 10 – Descriptive Statistics in Game Variables

<table>
<thead>
<tr>
<th></th>
<th>Direct Quiz Group Averages</th>
<th>Customized Content Group Averages</th>
</tr>
</thead>
<tbody>
<tr>
<td>Game Score (pts)</td>
<td>366.8</td>
<td>143</td>
</tr>
<tr>
<td>Total Time Played (sec)</td>
<td>536.7</td>
<td>861.9</td>
</tr>
<tr>
<td>ATR (sec)</td>
<td>17.9</td>
<td>16.8</td>
</tr>
<tr>
<td>Viewed Questions</td>
<td>34.4</td>
<td>57.2</td>
</tr>
<tr>
<td>Skipped Questions</td>
<td>3.4</td>
<td>10.2</td>
</tr>
<tr>
<td>Continue Button Count</td>
<td>2.5</td>
<td>4.9</td>
</tr>
</tbody>
</table>

Graph 1: In Game Statistics

Graph 2: In Game statistics
**5.1 ATR and Total Time Played Analysis**

In Figure 9 the average values of each variable recorded of the two groups are presented in a compact form to show the differences between the two groups. Additionally, the Graphs 1 & 2 & 3 in Figures 10 & 11 present also in a graphical way the data that were recorded from all the participants sessions. As far as the ATR variable is concerned, in both groups it is on similar levels which indicates that the relative interest based on the required knowledge to perform this test is also at similar levels. Having in mind that, Kickmeier et all (2011) considered that the average relative time to respond in educational games is an indication of their motivation towards the game as well as their competence on the difficulty of the task, thus they used that variable for their adaptation technique of micro and macro level interventions. In our case, we will use this ATR variable to measure mostly the relative difficulty towards the task from the students as well as their relative competence towards it. This means that the game managed to draw their attention on equal levels and that occurs because the game is tailored for their review. However, the Customized Content group
had the ATR slightly decreased which is also logical since they chose what they wanted mostly to be challenged on which will make them probably more familiar with what they chose from the start, and therefore have a faster response to most of the questions. So, if that is the case, then, it is expected from them to answer slightly faster than the Direct Quiz group. On the other hand, the Total Time Played from the Direct Quiz group was higher than the Customized Content group (Figure 10, Graph 1) and with less Skipped Questions (Figure 10, Graph 2). Which we can analyze further for their significance with unpaired t tests.

For more details, in the unpaired t test of the ATR variable, (Figure 12) we can observe that there is no significant difference between the means of the two groups. Thus, we can support the claim that both groups had in similar levels the average time to respond variable (ATR), which is also to be expected, since the sample is from a homogenous group and their knowledge and skills are approximately the same. However, on the unpaired t test of the total time played (TTP) of the participants (Figure 13), we can observe that there is a significant difference between the means of the two groups. Which can provide support to the claim that the Direct Quiz group which is the one that had averagely more time played, was more interested in, or enjoyed more the quiz, than the Customized Content group. However other variables must be taken under consideration as well, such as the unpaired t tests on the IMI subscale results as well as the overall average differences between the two group on the other variables: Viewed Questions, Skipped Questions and Intention to Continue.
### Figure 12 - Average Time to Respond (ATR) Unpaired t Test

DQ group = $\mu_1$, CC group = $\mu_2$

<table>
<thead>
<tr>
<th></th>
<th>Two tailed test</th>
<th>Right tailed test</th>
<th>Left tailed test</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ho: $\mu_1 = \mu_2$</td>
<td>$\alpha = 0.05$</td>
<td></td>
<td>$\alpha = 0.05$</td>
</tr>
<tr>
<td>Ho: $\mu_1 &lt; \mu_2$</td>
<td>$\alpha = 0.05$</td>
<td></td>
<td>$\alpha = 0.05$</td>
</tr>
<tr>
<td>Ho: $\mu_1 &gt; \mu_2$</td>
<td>$\alpha = 0.05$</td>
<td></td>
<td>$\alpha = 0.05$</td>
</tr>
</tbody>
</table>

| Alpha level | 0.050 | 0.050 | 0.050 |
| Sample size for group 1 | $n_1$ | 17.000 | 17.000 | 17.000 |
| Sample mean for group 1 | $\bar{x}_1$ | 16.732 | 16.732 | 16.732 |
| SD for group 1 | $S_1$ | 7.039 | 7.039 | 7.039 |
| Sample size for group 2 | $n_2$ | 20.000 | 20.000 | 20.000 |
| Sample mean for group 2 | $\bar{x}_2$ | 17.836 | 17.836 | 17.836 |
| SD for group 2 | $S_2$ | 7.740 | 7.740 | 7.740 |

Test Statistic: $t = -0.4506$
Critical Value(s): $t_{0.05} = 2.0301$, $t_{0.025} = 1.6896$, $t_{0.025} = -1.6896$

P Value: $p = 0.6551$

Decision: Do Not Reject $H_0$

Below is the confidence interval for un-paired difference based on the data from the two-tailed test (Column B).

Confidence level is equal to 1 - the alpha level in column B

Confidence Interval: $-6.078 < (\bar{x}_1 - \bar{x}_2) < 3.870$

### Figure 13 - Total Time Played (TTP) Unpaired t Test

DQ group = $\mu_1$, CC group = $\mu_2$

<table>
<thead>
<tr>
<th></th>
<th>Two tailed test</th>
<th>Right tailed test</th>
<th>Left tailed test</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ho: $\mu_1 = \mu_2$</td>
<td>$\alpha = 0.05$</td>
<td></td>
<td>$\alpha = 0.05$</td>
</tr>
<tr>
<td>Ho: $\mu_1 &lt; \mu_2$</td>
<td>$\alpha = 0.05$</td>
<td></td>
<td>$\alpha = 0.05$</td>
</tr>
<tr>
<td>Ho: $\mu_1 &gt; \mu_2$</td>
<td>$\alpha = 0.05$</td>
<td></td>
<td>$\alpha = 0.05$</td>
</tr>
</tbody>
</table>

| Alpha level | 0.050 | 0.050 | 0.050 |
| Sample size for group 1 | $n_1$ | 17.000 | 17.000 | 17.000 |
| Sample mean for group 1 | $\bar{x}_1$ | 861.789 | 861.789 | 861.789 |
| SD for group 1 | $S_1$ | 305.405 | 305.405 | 305.405 |
| Sample size for group 2 | $n_2$ | 20.000 | 20.000 | 20.000 |
| Sample mean for group 2 | $\bar{x}_2$ | 536.660 | 536.660 | 536.660 |
| SD for group 2 | $S_2$ | 240.603 | 240.603 | 240.603 |

Test Statistic: $t = 3.6215$
Critical Value(s): $t_{0.05} = 2.0301$, $t_{0.025} = 1.6896$, $t_{0.025} = -1.6896$

P Value: $p = 0.0009$

Decision: Reject $H_0$

Below is the confidence interval for un-paired difference based on the data from the two-tailed test (Column B).

Confidence level is equal to 1 - the alpha level in column B

Confidence Interval: $142.871 < (\bar{x}_1 - \bar{x}_2) < 507.387$
5.2 Viewed Questions, Skipped Questions and Intention to Continue

In Figure 10, Graph 2 we can also observe that the indication of the intention to continue was higher in the CC group than in the DQ group, however one thing to take under consideration is that the CC group had significantly more Skipped Questions than the DQ group, which made the participants of the CC group viewing more questions and eventually having more intention to continue recorded on their session, since that is measured every 10 questions that the participant is being asked whether they want to continue or not. Therefore, one thing that enhances the possible result of the increased interest on the Quiz from the CC group is the amount of Viewed Questions that they had in comparison to the DQ group. This could provide support for the claim that, there is increased motivation from the CC group however other variables must be taken under consideration as well, such like the IMI questionnaire results on Task Evaluation, that were gathered after each game session of the students.

5.3 IMI -Task Evaluation Questionnaire Analysis for Enjoyment / Interest

In Figure 14, the subscale of the IMI task evaluation questionnaire of Interest/Enjoyment is presented in a detailed independent unpaired t test. Even though there is not a significant difference between the means of the two groups one thing that is worth noting is that they do have some distance between each other as mean values and therefore we can see also from the t test (Figure 12, column B) that the possibility of the mean of the DQ group being smaller than the mean of the CC group can be rejected. Which means that there is significant low chance of the DQ mean being higher than the CC group. In addition, the unpaired t test in combination with the results of the t test on Pressure / Tension makes clearer what group was more interested into playing the Quiz.

5.4 IMI -Task Evaluation Questionnaire Analysis for Pressure / Tension

From the analysis on the subscale of the IMI on Pressure / Tension the results of the unpaired t test (Figure 15) we can see that there is no significant difference between the means of the two groups and therefore we can note that both groups had similar levels of pressure or tension which supports the fact that the IMI questionnaire and the experiment happened in a not invasive way. Moreover, it also indicates that both
approaches of the two versions of the game were well designed to not exercise any pressure and tension and that all of the information for this optional research experiment was clearly given.

**Figure 14 – IMI Questionnaire, Interest / Enjoyment, Unpaired t Test**

DQ group = $\mu_1$, CC group = $\mu_2$

<table>
<thead>
<tr>
<th>Two tailed test</th>
<th>Right tailed test</th>
<th>Left tailed test</th>
</tr>
</thead>
<tbody>
<tr>
<td>$Ho: \mu_1 = \mu_2$</td>
<td>$Ho: \mu_1 \leq \mu_2$</td>
<td>$Ho: \mu_1 \geq \mu_2$</td>
</tr>
<tr>
<td>$Ha: \mu_1 \neq \mu_2$</td>
<td>$Ha: \mu_1 &gt; \mu_2$</td>
<td>$Ha: \mu_1 &lt; \mu_2$</td>
</tr>
</tbody>
</table>

| Alpha level | 0.050 | 0.050 | 0.050 |
| Sample size for group 1 $n_1$ | 17.000 | 17.000 | 17.000 |
| Sample mean for group 1 | 39.412 | 39.412 | 39.412 |
| SD for group 1 $S_1$ | 6.185 | 6.185 | 6.185 |
| Sample size for group 2 $n_2$ | 20.000 | 20.000 | 20.000 |
| Sample mean for group 2 | 34.100 | 34.100 | 34.100 |
| SD for group 2 $S_2$ | 10.310 | 10.310 | 10.310 |

Test Statistic: 1.9313
Critical Value(s): ±2.0395, 1.6955, -1.6955
P Value: 0.0626, 0.0313, 0.9687
Decision: Do Not Reject $Ho$, Reject $Ho$, Do Not Reject $Ho$

Below is the confidence interval for un-paired difference based on the data from the two-tailed test (Column B).

Confidence level is equal to 1 - the alpha level in column B

| Confidence Interval | -0.298 $\leq (\mu_1 - \mu_2)$ $\leq$ 10.922 |

**Figure 15 - IMI Questionnaire, Pressure / Tension, Unpaired t Test**

DQ group = $\mu_1$, CC group = $\mu_2$

<table>
<thead>
<tr>
<th>Two tailed test</th>
<th>Right tailed test</th>
<th>Left tailed test</th>
</tr>
</thead>
<tbody>
<tr>
<td>$Ho: \mu_1 = \mu_2$</td>
<td>$Ho: \mu_1 \leq \mu_2$</td>
<td>$Ho: \mu_1 \geq \mu_2$</td>
</tr>
<tr>
<td>$Ha: \mu_1 \neq \mu_2$</td>
<td>$Ha: \mu_1 &gt; \mu_2$</td>
<td>$Ha: \mu_1 &lt; \mu_2$</td>
</tr>
</tbody>
</table>

| Alpha level | 0.050 | 0.050 | 0.050 |
| Sample size for group 1 $n_1$ | 17.000 | 17.000 | 17.000 |
| Sample mean for group 1 | 11.882 | 11.882 | 11.882 |
| SD for group 1 $S_1$ | 5.061 | 5.061 | 5.061 |
| Sample size for group 2 $n_2$ | 20.000 | 20.000 | 20.000 |
| Sample mean for group 2 | 12.550 | 12.550 | 12.550 |
| SD for group 2 $S_2$ | 5.781 | 5.781 | 5.781 |

Test Statistic: -0.3706
Critical Value(s): ±2.0301, 1.6896, -1.6896
P Value: 0.7132, 0.6434, 0.3566
Decision: Do Not Reject $Ho$, Do Not Reject $Ho$, Do Not Reject $Ho$

Below is the confidence interval for un-paired difference based on the data from the two-tailed test (Column B).

Confidence level is equal to 1 - the alpha level in column B

| Confidence Interval | -4.327 $\leq (\mu_1 - \mu_2)$ $\leq$ 2.991 |
5.5 IMI -Task Evaluation Questionnaire Analysis for Perceived Choice

In Figure 16 the unpaired t test for the Perceived Choice of participants showed that there was a significant difference on how they perceived their choice of participating on the Quiz experiment. Even though each of the participants were asked from the teacher whether they would like to participate to this serious game experiment or not and informed them that they can if they do not want to participate, there seems to be a significant difference on these metrics from the two groups. More specifically the DQ group seems to have a lot less indication of Perceived Choice than the CC group, which can support the claim that since the DQ group had no adaptability nor customized content featured they felt they had no choice or impact on what they would going to be reviewing on. On the other hand, the Pressure / Tension results showed no significant difference between the two groups, which also supports that both groups had similar levels of pressure or perceived choice to participate or to influence the experiment.

5.6 IMI -Task Evaluation Questionnaire Analysis for Perceived Competence

As far as the Perceived Competence subscale is concerned, the results from the unpaired t test on the two groups, (Figure 17) shows how there is no significant difference between the means of the two groups which can support the claim that both groups had felt the same competence against the Quiz and their knowledge levels which makes the whole experiment more valuable and valid since this is what we were striving for, to have a homogenous group as far as the knowledge level is concerned and test the customization content feature in isolation on this sample. Moreover, this is as expected, since if this would have a significant difference then whole Quiz would not have meaningful results since the sample would have significant different knowledge skills and competence.
**Figure 16 - IMI Questionnaire, Perceived Choice, Unpaired t Test**

DQ group = $\mu_1$, CC group = $\mu_2$

<table>
<thead>
<tr>
<th></th>
<th>Two tailed test</th>
<th>Right tailed test</th>
<th>Left tailed test</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ho: $\mu_1 = \mu_2$</td>
<td>$\mu_1 = \mu_2$</td>
<td>$\mu_1 &lt; \mu_2$</td>
<td>$\mu_1 &gt; \mu_2$</td>
</tr>
<tr>
<td>Ha: $\mu_1 \neq \mu_2$</td>
<td>$\mu_1 &gt; \mu_2$</td>
<td>$\mu_1 &lt; \mu_2$</td>
<td>$\mu_1 &lt; \mu_2$</td>
</tr>
</tbody>
</table>

| Alpha level          | 0.050           | 0.050             | 0.050           |
| Sample size for group 1 $n_1$ | 17.000         | 17.000            | 17.000          |
| Sample mean for group 1 | 27.353         | 27.353            | 27.353          |
| SD for group 1 $S_1$    | 4.286           | 4.286             | 4.286           |
| Sample size for group 2 $n_2$ | 20.000         | 20.000            | 20.000          |
| Sample mean for group 2 | 22.500         | 22.500            | 22.500          |
| SD for group 2 $S_2$    | 4.560           | 4.560             | 4.560           |

Test Statistic: 3.3157
Critical Value(s): ±2.0301, 1.6896, -1.6896
P Value: 0.0021, 0.0011, 0.9989

Decision: Reject Ho, Reject Ho, Do Not Reject Ho

Below is the confidence interval for un-paired difference based on the data from the two-tailed test (Column B):

Confidence Interval: $1.882 \leq (\mu_1 - \mu_2) \leq 7.824$

**Figure 17 - IMI Questionnaire, Perceived Competence, Unpaired t Test**

DQ group = $\mu_1$, CC group = $\mu_2$

<table>
<thead>
<tr>
<th></th>
<th>Two tailed test</th>
<th>Right tailed test</th>
<th>Left tailed test</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ho: $\mu_1 = \mu_2$</td>
<td>$\mu_1 = \mu_2$</td>
<td>$\mu_1 &lt; \mu_2$</td>
<td>$\mu_1 &gt; \mu_2$</td>
</tr>
<tr>
<td>Ha: $\mu_1 \neq \mu_2$</td>
<td>$\mu_1 &gt; \mu_2$</td>
<td>$\mu_1 &lt; \mu_2$</td>
<td>$\mu_1 &lt; \mu_2$</td>
</tr>
</tbody>
</table>

| Alpha level          | 0.050           | 0.050             | 0.050           |
| Sample size for group 1 $n_1$ | 17.000         | 17.000            | 17.000          |
| Sample mean for group 1 | 23.765         | 23.765            | 23.765          |
| SD for group 1 $S_1$    | 6.270           | 6.270             | 6.270           |
| Sample size for group 2 $n_2$ | 20.000         | 20.000            | 20.000          |
| Sample mean for group 2 | 20.300         | 20.300            | 20.300          |
| SD for group 2 $S_2$    | 8.850           | 8.850             | 8.850           |

Test Statistic: 1.3505
Critical Value(s): ±2.0301, 1.6896, -1.6896
P Value: 0.1855, 0.0928, 0.9072

Decision: Do Not Reject Ho, Do Not Reject Ho, Do Not Reject Ho

Below is the confidence interval for un-paired difference based on the data from the two-tailed test (Column B):

Confidence Interval: $-1.744 \leq (\mu_1 - \mu_2) \leq 8.674$
6 Conclusions

6.1 Summary

The most important finding from this experiment is that even with the minimum
content customization or personalization that occurs we can observe that there is a
significant difference in the Total amount of time played from each user from the two
groups. The DQ group results on Total Time Played has a significant indication that
they will not be the same with the CC group (Figure 13), thus there is an important
claim that we can support, that this Content Customization feature did have a negative
impact on the motivation of the players since they played in total less time.

Additionally, there is more evidence to that claim, even if there is not a
significance in the next arguments, it is important to observe the IMI results on all the
subscales except of the Perceived Choice which we will discuss the reasons for that
as well. From the IMI subscale of Interest / Enjoyment (Figure 14) we can also observe
that both groups had similar levels on enjoyment which is a verified instrument for
measuring intrinsic motivation of the users in educational context. This could have
been better for the scope of this experiment, if there was a significant difference as
well to the Interest/Enjoyment subscale of the IMI results from one group. However,
this result combined with the significant importance of Total Time Played results can
support the evidence of the experiment results that the DQ group had indications of
beeing more motivated to play the Quiz and review their knowledge in comparison
from the CC group which they had the option to choose and customize the content
based on their desired topic.

This might have been due to the simplistic adaptation that occurs only after
minimal customization of the content, which was the intention of this study to isolate
the customize content feature and examine its effects on the players motivation for
learning. It also supports the fact that only the customization features are not enough
to keep the players motivated throughout the experience as there is no way with that
approach to re-examine what the player wants after the game has started. Thus, rising
to most of the players a demotivation feeling that cannot be assessed anyhow since
there is no other method of adjusting after the initial. In comparison the DQ group that
did not have the choice at all did not think of this as they were not given the chance
to. Thus, they adapted to that environment knowing that randomness is expected and
that their choices or needs did not have a lot of impact on the content that they were exposed to.

In addition, the results from the unpaired t test on the IMI Pressure/Tension subscale (Figure 15) indicate that both groups had no significant difference to their experience with the Quiz and the experiment, thus supporting the claim of them being aware of their choice to participate and that they had ability to quit anytime if desired was clear from the beginning of their introduction with the Trikat-Quiz and the experiment.

In the analysis of the Perceived Choice subscale of the IMI (Figure 16), we can observe that there is a significant difference between the means of the two groups, which can be a barrier to be deriving to a result about their desire to participate in the experiment. On the other hand, all the participants were informed before their statement to participate that they could of course choose to stay in the class lecture. Therefore, the results of the Perceived Choice could be rejecting the hypothesis that they are significantly different but that is also accountable due to the hours that they were occupied from. Since one group of participants could be occupied from Gymnastics for example which they could participate to the event and then go out and play with their fellow students on whatever activity they would be doing. Therefore, some students might have felt that they kind of had no other choice, but that is wrong since they were informed they could choose not to participate. This could possibly explain why the subscale of perceived choice should not be accountable for this study as it was clearly stated to the student participants that this was an optional event for them to experience an educational serious game, however as we said earlier, factors like what class were the students occupied from during the experiment have to also be considered, since they could possibly affect the students’ motivation to participate in the experiment.

6.2 Discussion

Even though the sample’s knowledge level was approximately the same and this can also be verified by the ATR variable which is on similar levels in both groups, the DQ group had significantly more Total Time played and slightly lower average on ATR but with no significance. In addition, on the IMI Perceived Competence subscale results, the average values are on similar levels, which supports that both groups were
facing the quiz with approximately the same competence. However even though both groups had the same amount of given time to be played, one thing to take under consideration is that the sample was broken down into four sub groups instead of the planned two groups.

This might have affected the students differently as the time that they were occupied was taken from other courses, thus every sub group was occupied from a different course, which might have played a role in their interest to play the game instead of being in class. On the other hand, both groups enjoyed the experiment even though they did not know that it was about an educational review game tailored for their review needs. Both groups had participants that stated that it would be very nice to have these kinds of games in the class lectures, which enhances the whole meaning of the experiment. In addition, from the only 7 responses on the open questions among all participants some of those were indicating that they had a nice time with the quiz and that it was a good exercise for reviewing, while other stated some irrelevant to the study comments, such as the statement that they had the best score or that they had done a better score than someone else. It is not any significant indication that one group had more involvement with the quiz than the other group, since it also subjective to the characteristics of each student and how they express their emotions.

However, there were also having a behavior that was more social than personal through this experiment and thus the game became the subject of the talk, which is very interesting as it shows that both groups had interest towards this activity, with – or without the content customization feature. This also supports how the special tailored serious games can be of a benefit for students in all kind of educational environments, so that they can review the content and therefore, to be doing a better work as an educational tool by keeping the players motivated to their goals and needs. Even if this pattern of adaptability showed that there was not a significant difference between the interest of the two groups towards the activity, other adaptation techniques and personalized games can provide of suggestions on how to better approach this issue of personalization.

For this research the purpose was to examine the minimum content customization in an educational game environment and examine its impact on the motivation of the students, in comparison to a control group that had no customization option and thus serving as a control group. We concluded that there is no significant difference among the two groups but with a strong indication that this simplistic
customization of the content had a negative impact on the overall motivation of the participants. However, this only shows that further studies can examine different kind of adaptation approaches to examine what are the most successful factors of a serious game.

6.3 Future Work

In this thesis the relationship between motivation, content customization and personalization were examined, however further research could offer more insight to this problem and what is are the best practices for applying the feature of content customization in educational games. Future work could investigate whether if the combination of customization with personalized systems can be used to achieve individualization for the task. More research needs to be done, to understand and analyze further how educational games can be of important use in real educational and they can be tailored to serve very specific tasks. This makes it more like a tool which could possibly be personalized to the needs of the course and then in game have a customization feature for the user, so that their desired goal in the given context can be achieved. It is also worth examining how the same experiment could perform to another school or possibly to other educational environments. Lastly, future analysis on content customization and personalization can show that their combination might be the key to achieve highly motivated serious games that can perform reviewing and learning activities for educational settings.
References


Appendices

Appendix A - IMI Task Evaluation Questionnaire

TASK EVALUATION QUESTIONNAIRE
For each of the following statements, please indicate how true it is for you, using the following scale:

<table>
<thead>
<tr>
<th></th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>not at all</td>
<td>Somewhat true</td>
<td>Very true</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

1. While I was working on the task I was thinking about how much I enjoyed it.
2. I did not feel at all nervous about doing the task.
3. I felt that it was my choice to do the task.
4. I think I am pretty good at this task.
5. I found the task very interesting.
6. I felt tense while doing the task.
7. I think I did pretty well at this activity, compared to other students.
8. Doing the task was fun.
9. I felt relaxed while doing the task.
10. I enjoyed doing the task very much.
11. I didn’t really have a choice about doing the task.
12. I am satisfied with my performance at this task.
13. I was anxious while doing the task.
14. I thought the task was very boring.
15. I felt like I was doing what I wanted to do while I was working on the task.
16. I felt pretty skilled at this task.
17. I thought the task was very interesting.
18. I felt pressured while doing the task.
19. I felt like I had to do the task.
20. I would describe the task as very enjoyable.
21. I did the task because I had no choice.
22. After working at this task for awhile, I felt pretty competent.

Scoring information. Begin by reverse scoring items # 2, 9, 11, 14, 19, 21. In other words, subtract the item response from 8, and use the result as the item score for that item. This way, a higher score will indicate more of the concept described in the subscale's name. Thus, a higher score on pressure/tension means the person felt more pressured and tense; a higher score on perceived competence means the person felt more competent; and so on. Then calculate subscale scores by averaging the items scores for the items on each subscale. They are as follows. The (R) after an item number is just a reminder that
Appendix B - Direct Quiz group – Data

<table>
<thead>
<tr>
<th>Test ID</th>
<th>Name</th>
<th>Gender</th>
<th>Age</th>
<th>Total Points</th>
<th>Total Time Played</th>
<th>Total Quiz Group Points</th>
<th>Total Customized Content Group Points</th>
<th>Total Points Total</th>
<th>Total Time Played Total</th>
</tr>
</thead>
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<tr>
<td>1</td>
<td>John</td>
<td>Male</td>
<td>20</td>
<td>120</td>
<td>30</td>
<td>20</td>
<td>30</td>
<td>150</td>
<td>60</td>
</tr>
<tr>
<td>2</td>
<td>Jane</td>
<td>Female</td>
<td>30</td>
<td>90</td>
<td>45</td>
<td>30</td>
<td>30</td>
<td>120</td>
<td>90</td>
</tr>
<tr>
<td>3</td>
<td>Mike</td>
<td>Male</td>
<td>35</td>
<td>180</td>
<td>60</td>
<td>60</td>
<td>60</td>
<td>300</td>
<td>120</td>
</tr>
</tbody>
</table>

Appendix C - Customized Content group - Data

<table>
<thead>
<tr>
<th>Test ID</th>
<th>Name</th>
<th>Gender</th>
<th>Age</th>
<th>Total Points</th>
<th>Total Time Played</th>
<th>Total Quiz Group Points</th>
<th>Total Customized Content Group Points</th>
<th>Total Points Total</th>
<th>Total Time Played Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>John</td>
<td>Male</td>
<td>20</td>
<td>120</td>
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<td>20</td>
<td>30</td>
<td>150</td>
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<tr>
<td>2</td>
<td>Jane</td>
<td>Female</td>
<td>30</td>
<td>90</td>
<td>45</td>
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<td>30</td>
<td>120</td>
<td>90</td>
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<tr>
<td>3</td>
<td>Mike</td>
<td>Male</td>
<td>35</td>
<td>180</td>
<td>60</td>
<td>60</td>
<td>60</td>
<td>300</td>
<td>120</td>
</tr>
</tbody>
</table>
Appendix D - Algebra Questions in Greek

Ερωτήσεις Άλγεβρας

1. Ο αριθμός (-3)4 ισούται με:
   A. 81
   B. 12
   C. -12
   Δ. -81

2. Το διπλάσιο του ισούται με:
   A. 12
   B. 6
   C. -6
   Δ.

3. Τα μονώνυμα 5x3y2 και -y2x3 είναι:
   A. Ίσα
   B. Αντίθετα
   C. Σταθερά
   Δ. Μηδενικά

4. Το πολυώνυμο Ρ(x) = 3(x - 1)2 - 3x2 + 5 είναι:
   A. Πρώτου βαθμού
   B. Μηδενικού βαθμού
   C. Δευτέρου βαθμού
   Δ. Τρίτου βαθμού

5. Τα πολυώνυμα Ρ(x) = x3 - βx + 5 και Q(x) = x3 + βx2 + 5 - β , β ∈ R είναι ίσα, όταν το β ισούται με:
   A. -1
   B. 5
   C. 1
   Δ. 0

6. Αν 6v = 7.776, τότε η παράσταση Β = 3v · 5 · 2v ισούται με:
   A. 7.776
   B. 5v
   Γ. 38.880
   Δ. τίποτα από τα προηγούμενα

7. Η παράσταση Α = 100.0012 - 99.9992 ισούται με:
   A. 400.000
   B. 4
   Γ. 8
   Δ. 20.000
8. Η παράσταση Α = 4 – x² ισούται με:
   A. (4 – x) (4 + x)
   B. (x - 4)²
   Γ. (4 - x)²
   Δ. (2 – x) (2 + x)

9. Δίνεται η εξίσωση ax²+βx+γ = 0, a≠0. Όταν η διακρίνουσα είναι μηδέν, τότε η εξίσωση έχει:
   A. Μία διπλή λύση
   B. Πολλές λύσεις
   Γ. Δύο λύσεις
   Δ. Καμία λύση

10. Η διακρίνουσα της εξίσωσης -x² +4x -3 = 0 είναι:
    A. 28
    B. 4
    Γ. 0
    Δ. -4

11. Η ισότητα (α + β)² = α² + β², ισχύει όταν:
    A. α = β
    B. α = -β
    Γ. α = 0 ή β = 0
    Δ. Τίποτα από τα παραπάνω

12. Η εξίσωση 2x² – 50 = 0 έχει ως λύση:
    A. x = 5
    B. x = -5
    Γ. x = 25
    Δ. x = 5 ή x = 5

13. Αν α > 4, τότε:
    A. –α > 4
    B. –2α > 2
    Γ. 2α > 2
    Δ. -α < -4

14. Η παράσταση είναι 2x 2 y+3x κ γλ είναι μονώνυμο αν:
    A. κ = 1 και λ = 2
    B. λ = 1 και κ = 2
    Γ. λκ = 2
    Δ. λ = κ = 3

15. Τα μονώνυμα (λ2-1)-α2· βλ και 8·α2 ·β3 είναι ίσα, αν το λ είναι:
    A. 3
    B. –3
    Γ. 3 ή –3
    Δ. 9
Appendix E – Geometry Questions in Greek

Να βρεις τη σωστή απάντηση στις παρακάτω ερωτήσεις:

1. Αν ΔΕ // ΒΓ, τότε:

   a) \( \frac{ΔΒ}{ΕΓ} = \frac{ΑΒ}{ΑΓ} \)
   b) \( \frac{ΔΔ}{ΔΒ} = \frac{ΕΓ}{ΑΕ} \)
   c) \( \frac{ΑΒ}{ΑΕ} = \frac{ΑΕ}{ΑΓ} \)
   d) \( \frac{ΔΔ}{ΔΒ} = \frac{ΕΓ}{ΑΕ} \)

2. Το χρόνο γωνίας 90° ισούται με:
   a) 0
   b) -1
   c) 1
   d) δεν ορίζεται

3. Το χρόνο γωνίας 140° ισούται με:
   a) -συν40°
   b) -ημι40°
   c) συν40°
   d) ημι40°

4. Ένα από τα κριτήρια ισοτύπων τριγώνων λέει ότι δύο τρίγωνα είναι ίσα αν και μόνο αν έχουν ίσες μία προς μία:
   a) τις πλευρές
   b) τις γωνίες
   c) τις γωνίες και τις πλευρές
   d) κανένα από τα προηγούμενα

5. Σε ένα τρίγωνο οι δύο γωνίες του είναι 34° και 68°. Η τρίτη θα είναι:
   a) 34°
   b) 68°
   c) 102°
   d) 78°

6. Ένα ισοσκελές τρίγωνο με μια γωνία 50° είναι:
   a) ισοσκελές
   b) ισόπλευρο
   c) αμφίλεγκτο
   d) ορθάγωνο

7. Σε ένα ορθόγωνο τρίγωνο η διάμεσος που αντιστοιχεί στην υποτείνουσα είναι 4 cm. Η υποτείνουσα του θα είναι:
   a) 4 cm
   b) 8 cm
   c) 12 cm
   d) 2 cm

8. Ένα σημείο ισοπέδωσε από τις κορυφές Α και Β του τριγώνου ΑΒΓ. Αυτό σημαίνει ότι βρίσκεται πάνω:
   a) στη διχοτομία της \( \tilde{A} \)
   b) στη διχοτομία της \( \tilde{B} \)
   c) στη μεσοκάθετο του \( AB \)
   d) στη μεσοκαθετο του \( A \) και του \( B \)
9. Αν η εφαπτομένη γωνίας δεν αριστεί, η γωνία μπορεί να είναι:
   a) 0°  
   b) 30°  
   c) 45°  
   d) 90°

10. Η γωνία με εφαπτομένη 1 είναι:
    a) 0°  
    b) 30°  
    c) 45°  
    d) 60°

11. Η εφαπτομένη γωνίας 120° ισούται με:
    a) ημ60°  
    b) εφ60°  
    c) συν120°  
    d) −εφ60°

12. Το συνημίτονο μιας γωνίας 150° ισούται με:
    a) ημ30°  
    b) συν30°  
    c) −ημ30°  
    d) −συν30°

13. Δίνονται τα ομοια ισοσκελή τρίγωνα ΑΒΓ και ΔΕΖ
tου σχήματος. Η γωνία φ είναι ίση με:
    a) 50°  
    b) 65°  
    c) 55°
    d) δεν γνωρίζουμε

14. Αν ο λόγος των εμβαδών δύο ισόπλευρων τριγώνων είναι \( \frac{36}{49} \), τότε ο λόγος των πλευρών
tους είναι:
    a) \( \frac{6}{7} \)  
    b) \( \frac{6}{49} \)  
    c) \( \frac{36}{7} \)  
    d) δεν γνωρίζουμε

15. Από τους παρακάτω τριγωνομετρικούς αριθμούς αριθμητικός είναι:
    a) ημ150°  
    b) συν90°  
    c) εφ45°  
    d) εφ150°
Appendix F – Physics Questions in Greek

1) Οι ηλεκτρικές αλληλεπιδράσεις οφείλονται σε μια ιδιότητα της ύλης που ονομάζεται:
   A) ηλεκτρική δύναμη
   B) ηλεκτρικό φορτίο
   Γ) ηλέκτριση
   Δ) πόλωση

2) Στη φύση δεν είναι δυνατό να υπάρξει σώμα με φορτίο: (δύο σωστές απαντήσεις)
   A) 3,2 · 10⁻¹⁹ C
   B) 3 · 10⁻¹⁹ C
   Γ) 6,4 · 10⁻¹⁹ C
   Δ) 6,4 · 10⁻²⁰ C

3) Σε ποια από τις εικόνες 1,2 και 3 που φαίνονται στο διπλανό σχήμα τα δύο σφαιρίδια από φελιζόλ που είναι κρεμασμένα με μεταξωτή κλωστή:
   A) είναι οροισμένα με αντίθετο είδος φορτίου
   B) είναι οροισμένα με ίδιο είδος φορτίου
   Γ) είναι αφορτιστά

4) Ποια από τις επόμενες γραφικές παραστάσεις αποδίδει σωστά τη σχέση μεταξύ της αντίστασης ενός αντιστάτη και της έντασης του ρεύματος που τον διαρρέει; Να κυκλώσεις το αντίστοιχο γράμμα.

5) Όταν σε ένα κύκλωμα διπλασιάζεται η τάση στα άκρα του διατηρώντας σταθερή την ηλεκτρική αντίσταση τότε η ένταση του ηλεκτρικού ρεύματος:
   A) τετραπλασιάζεται
   B) παραμένει αμετάβλητη
   Γ) υποτετραπλασιάζεται
   Δ) διπλασιάζεται
6) Ποια από τις παρακάτω προτάσεις είναι σωστή;
A) Μια πιο εύχρηστη μονάδα ισχύος είναι η 1 kWh.
B) Η ηλεκτρική ισχύς που μετασχηματίζει μια συσκευή είναι ανεξάρτητη από την τάση που επικρατεί στα άκρα της.
Γ) Όλες οι ηλεκτρικές συσκευές έχουν απόδοση 100 %.
Δ) Η ηλεκτρική ισχύς που καταναλώνει μια συσκευή είναι ανάλογη προς την ένταση I του ρεύματος που τη διαρρέει.

7) Από την ΔΕΗ αγοράζουμε:
A) ηλεκτρικό ρεύμα
B) ηλεκτρικό φορτίο
Γ) ηλεκτρική ενέργεια
Δ) ηλεκτρική τάση

8) Ποια από τις επόμενες προτάσεις που αναφέρονται στα εγκάρσια κύματα είναι λανθασμένη;
A) Διαδίδονται σχηματίζοντας ′όρη′ και ′κοιλάδες′.
B) Τα σωματίδια του μέσου στο οποίο διαδίδονται ταλαντώνονται κάθετα στη διεύθυνση διάδοσης του κύματος.
Γ) Διαδίδονται στα στερεά, στα υγρά και στα αέρια σώματα.
Δ) Δεν μεταφέρουν ύλη.

9) Ποια από τις επόμενες προτάσεις που αναφέρονται στα διαμήκη κύματα είναι λανθασμένη;
A) Διαδίδονται σχηματίζοντας πυκνώματα και αραιώματα.
B) Τα σωματίδια του μέσου στο οποίο διαδίδονται ταλαντώνονται κατά τη διεύθυνση διάδοσης του κύματος.
Γ) Διαδίδονται στα στερεά, στα υγρά και στα αέρια σώματα.
Δ) Μεταφέρουν ύλη.

10) Ένας ταλαντωτής συχνότητας f1 σε χρονικό διάστημα 4 s εκτελεί 4 πλήρεις ταλαντώσεις, ενώ ένας άλλος ταλαντωτής συχνότητας f2 σε χρονικό διάστημα 2 s εκτελεί 2 πλήρεις ταλαντώσεις. Ποια από τις παρακάτω σχέσεις είναι σωστή;
Ε) A) f1 > f2
2Τ) B) f1 = f2
Ζ) Γ) f1 < f2

11) Μήκος κύματος ενός εγκάρσιου κύματος είναι η απόσταση:
A) μεταξύ ενός ′όρους′ και μιας ′κοιλάδας′ του κύματος
B) μεταξύ δύο διαδοχικών ′όρεων′ ή δύο διαδοχικών ′κοιλάδων′ του κύματος
Γ) μεταξύ ενός πυκνώματος και ενός αραιώματος του κύματος
Δ) μεταξύ δύο διαδοχικών πυκνωμάτων ή δύο διαδοχικών αραιωμάτων του κύματος
12) Ποια από τις αποστάσεις που απεικονίζονται στο στιγμιότυπο του εγκάρσιου κύματος του δυτικανού σχήματος αποτελεί το μήκος κύματος του κύματος;
   Α) Η απόσταση \( \lambda_1 \)
   Β) Η απόσταση \( \lambda_2 \)
   Γ) Η απόσταση \( \lambda_3 \)
   Δ) Η απόσταση \( \lambda_4 \)

13) Ποιο από τα επόμενα σχήματα απεικονίζει σωστά τον τρόπο με τον οποίο βλέπουμε τα αντικείμενα;

14) Ποιες από τις προτάσεις είναι σωστές; Η διάχυση
   1. είναι η ανάκλαση του φωτός όταν πέφτει πάνω σε τραχιές επιφάνειες.
   2. γίνεται όταν πέφτει φως πάνω σε λείες επιφάνειες.
   3. υπάρχει όταν το φως περνάει από από ένα διαφανές μέσο σε ένα άλλο.
   4. έχει ως αποτέλεσμα να βλέπουμε όλα τα αντικείμενα γύρω μας όταν φωτίζονται.

15) Ποιο από τα τρία σχήματα που ακολουθούν είναι το σωστό; Να αιτιολογήσεις το γιατί τα δύο σχήματα που δεν επέλεξες είναι λάθος.
Αγαπητοί γονείς,

Θα θέλαμε να σας ενημερώσουμε για μια ερευνητική δραστηριότητα που θα διεκπεραιώθει στο σχολείο μας μέσα στην επόμενη εβδομάδα. Πρόκειται για ένα εκπαιδευτικό ψηφιακό παιχνίδι που έχει ως σκοπό να εξετάσει το κίνητρο και την κινητοποίηση των μαθητών ως προς τέτοιου είδους παιχνίδια. Με αυτό το μήνυμα θα θέλαμε να πάρουμε την συγκατάθεσή σας για τα παιδιά να συμμετάσχουν σε αυτήν την επαναληπτική δραστηριότητα.

Για οποιαδήποτε ερώτηση, ή αν επιθυμείτε το παιδί σας να μην συμμετάσχει παρακαλώ εποικονήστε μαζί μας.

Σας ευχαριστώ πολύ,

Κυριακούλης Φ. Κυριάκος
Γενικός Διευθυντής Εκπαιδευτηρίων
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Appendix H – Parental Consent Email in English

Dear parents,

We would like to inform you about a research activity that will take place in our school in the next coming week. The research activity is about an educational digital game that has as purpose to examine the motivation of the students towards this kind of games. With this message we would like to ask for you consent for the students to participate in this reviewing activity of their school material.

For any questions that you may have, or if you desire your child not to participate in this activity please contact us.

Thank you in advance,

Κυριακούλης Φ. Κυριάκος
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