INDIVIDUALISTIC VERSUS COMPETITIVE GAME-BASED E-LEARNING

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Abstract

In conventional teaching there are three major goal structures: competitive learning, cooperative learning and individualistic learning. There has been much research into the effectiveness of these goal structures in conventional teaching. In regards to computer-aided learning, cooperative learning has been researched in game-based e-learning (GBEL), but competitive learning has mostly been overlooked. This research investigates the impact that competition has on the effectiveness of GBEL. The results of the experiment showed that when the e-learning game was played in a competitive context there was a lower learning improvement than if the game was played in a non-competitive, individualistic context.

Key Words

Evaluation of CAL systems, computer games, human–computer interface, multimedia/hypermedia systems

1. Introduction

Crawford [1] asserts that the fundamental motivation of game playing is to learn. Games have been always used in the teaching and learning process. Board games for example are believed to be the earliest games and they were used as battle simulations designed to instruct the young [2].

Computer games however are treated quite differently from their traditional counterparts. Since their inception, computer games have caused concerns among educators and researchers [3]. They fear that their students would become addicted to games and thus neglect "real" learning which is well planned by schools. Some scholars however believe that like traditional games, the potential of computer games could be utilized for learning purposes [4]. Nevertheless, the research of computer game-based learning (GBEL) is always notorious for the lack of empirical data. The most widely cited author in this area, Prensky [4], recognizes the lack of quantitative analysis of effective-

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ness, but does not provide examples to substantiate his claims.

Games at present are becoming more multiplayer. Some games feature constructive collaborative working, which sees users work together to achieve goals and learn with one another. In this study we investigate the benefits of users working against each other, in competitive learning. The effectiveness of competition in conventional teaching and learning is a controversial issue of research [5]. However, Johnson and Johnson [5] go on to advise that "competitions need to be kept light and fun, emphasizing review or drill, probably in game format" to be successful. Others had advocated for collaborated instead of competitive learning. For example, Ewing and Miller [6] claim that "collaborative learning in an ITC (Information Technology and Communication) learning medium is both possible and acceptable".

This study attempts to discover the impact that the introduction of competition has on the effectiveness of learning in GBEL. The learning effectiveness of a game being played in competition must be assessed so that it is established whether competition is either a useful and successful motivational factor, increasing learning effectiveness or a distracting hindrance that decreases learning effectiveness.

We focus on two of these goal structures: competitive and individual GBEL. This study attempts to answer the following research question: "Will the learning effectiveness of an e-learning game be different if the e-learning game is played in a competitive or non-competitive context?"

2. Background/Literature Review

2.1 Computer Games and GBEL

There is no one single definition of game, as the academics are still working to refine it so that it could explain various kinds of games, including computer games. There are many definitions that try to describe different aspects of game. While some focus on the game itself, some concentrate on the activity of playing the game. In this work, we use Juul's definition which is stated as follows:

> "A game is a rule-based formal system with a variable and quantifiable outcome, where different outcomes are assigned different values, the player exerts effort in order to influence the outcome, the

player feels attached to the outcome, and the consequences of the activity are optional and negotiable." [7]

Probably the simplest definition of computer games, after reviewing Juul's definition, is that computer games are games played in a digitalized environment. Computer games are therefore a kind of game which is mediated through the use of electronic devices such as computers.

GBEL is a way of delivering educational material in a game format. Prensky [4] defines it as "[the] marriage of educational content and computer games". Games can range from simple quiz and trivia style offerings with next to no development costs offered over the Internet, to realistic battle simulations developed by the military for upwards of £3 million performed in military headquarters.

Although not many, some educators believe that computer games could be used in the classroom to engage students, making learning more enjoyable [3]. A few scholars have undertaken this project, defining elements of game design that might be used to make learning environments more engaging [8, 9]. For instance, Gee [10] describes gaming as a complex social practice where computer game players engage in high order thinking that requires complex cognitive effort. The overarching idea is that children learn to participate in new domains by playing computer games. They learn to make sense of new areas, not only on their own, but also by engaging with their peers, discussing and sharing information.

2.2 Evidence Supporting the Effectiveness of GBEL

A detailed survey was conducted by Randel *et al.* [11] which considered the instructional effectiveness of games to conventional classroom teaching. Although the report is 14 years old, and since then there have been significant technological advances in the complexity and capabilities of the games, it is still worth reporting some of their interesting findings. The authors compared 67 investigations where empirical data, rather than teachers' judgements, was used. Their results showed that of the 67 studies, 38 show no difference between games and conventional instruction; 22 favour games and 3 favour conventional instruction. Games that involved learning mathematics got the most positive comments.

2.3 Collaborative, Competitive and Individualistic Learning Theories

There are three types of interpersonal goal structures that can be used in teaching: individualization, cooperation and competition. In an environment where individualization is adopted the student goal achievement is independent and is unrelated to the goals of other students. In a cooperative environment student goals are linked, in that each student's performance and contribution has an effect on another's. Here student goals are positively correlated; when one student achieves his or her goal all students with whom (s)he is cooperatively linked achieve their goals [12].

In a competitive environment student goals are negatively correlated; when a student achieved his or her goals the other students who are competitively linked do not achieve their goals.

There are two ways that these goal structures have been approached. The first is concerned with intrinsic motivation [13], and the second is the extrinsic motivation theory from Deutsch [14]. Lewin's Field Theory is that goals are accomplished from individual motivation generated by a state of personal tension. According to Lewin cooperative, competitive and individualistic behaviours are the result of one's desire to achieve goals. Deutsch however saw that the tensions of individuals can be interrelated, for example in a cooperative situation a person will seek an outcome that is best for all other persons to whom he or she is linked.

2.3.1 Individualistic Learning

This is a relatively easy topic of learning to define. In essence it means learning on one's own, without the interference of others. It does not mean learning without teachers or supervisors. Kelley and Thibaut [15] define an individualistic learning structure as "one in which individuals are rewarded on the basis of the quality of their own work, independently of the work of other participants". In an individualistic learning environment the student seeks an outcome that is beneficial to themselves and themselves only. The efforts of other students are irrelevant and have no impact.

Having the ability to work effectively and constructively on one's own is an important competence, and historically individualistic learning is the most common approach of the three opposing goal structures. Johnson and Johnson [5] give five common characteristics of individualistic learning. Students must: (a) recognize that they have an individual fate unrelated to the fates of their peers; (b) strive for self-benefit to do the best they can irrespective of how their peers perform; (c) have a short-term perspective focused on maximizing their performance; (d) recognize that their identity depends on how their performance compares with the present criteria of excellence; (e) recognize that their performance is self caused by their own ability and effort. Individuals feel responsibility only to themselves and are invested in only their own success.

2.3.2 Competitive Learning

Competition is prevalent in all aspects of life. According to Johnson and Johnson [16] most children consider that school is a predominantly competitive environment. From an early age we are all made to compete in competitive acts whether it is on the football field, on the tennis court, for admission to university, in applying for jobs, to name but a few.

Deutsch [14], from a situational and social interdependence position, writes that competition occurs when people's goals are negatively correlated and when each individual perceives that when one person reaches his or her goals everyone else who is linked with that person fail to

achieve their goals. He also makes the useful and insightful point that it is difficult and often impossible to find instances of "pure" competition or cooperation. By this it is meant that every day life situations are a complex mix of goals and incentives and it is difficult to find instances where a goal is purely competitive or cooperative. This is often true in the classroom where students often want to beat each other in test scores. However, would rarely want to beat each other to cause detriment.

2.4 Research into the Effectiveness of Competition in GBEL

In the early days of computer games most were only playable by one person at a time. Nowadays most games have a multiplayer option. For many this makes playing games a great deal more fun, adding to motivation and perhaps a greater effect on learning. McGrenere [17] writes: "Using a multi-player game format could provide the motivation that children need to learn and at the same time both enhance the achievement and social interactions of the children". So if a game is going to be multiplayer it must be a cooperative game, a competitive game or both. There has been a great deal of research into group learning activities, some of which is described above. The general consensus is that when cooperative learning is used, whereby children work together, there are positive results in both academic results and interpersonal relations.

There has been very little research into the effect that the introduction of competition has on GBEL. Prensky [4] recognizes the importance of competition in games, and sees it as a motivational factor. He writes, "Conflict/competition/challenge, or opposition is what gets your adrenaline and creative juices flowing, and what makes you excited about playing the game. While not everyone likes head to head competition, and some people shy from conflict, most of us enjoy a challenge."

Prensky therefore sees competition as a very important motivational factor in the design of learning games. In addition, playing games in competition means that people are interacting with other people and are creating social groupings. In conventional computer games, where learning is not the primary concern, competition is a hugely important motivational factor in playing. So this motivational effect may transcend into GBEL.

3. Methods

To explore the effect that competition has on e-learning games, a controlled experiment was conducted.

3.1 Stimulus Material: Design of the Games

The most important aspect of the game was to ensure that it could be played both in a competitive and in a non-competitive way. The game was designed using Macromedia Flash as the front-end, supported by the PHP scripting language and running on a mySQL database. Contemporary computer games are highly sophisticated, some consisting of photo realistic world, videos and animations and other components. The game for this study is intended to be simplistic so that we can factor out other issues and focus on competition aspect of it.

3.2 Game Style

The game was in the format of a quiz. The players had to answer 15 multiple-choice questions in a row correctly to successfully finish the game. In the competitive version of the game three players were competing against each other, whoever answered the questions correctly first would win. The relative positions of the players were visible at all times. In the non-competitive version the player was playing on his or her own, and there was no winning or losing. The game had a "fantasy" theme and players positions were represented by spacecrafts. Each time a player answered a question correctly their spacecraft would move forward. If a player answered a question incorrectly the spaceship would start back at the beginning and the player needed to start back at Question 01. Before a player can begin, it was necessary to register. If a multiplayer competitive game was played the player was then taken to a game waiting screen, else the game started and the game window was displayed. In the waiting screen the players saw their spacecraft. The spacecraft had the players' names next to them. Each player could therefore see which craft belonged to which players. The game automatically started once three players had registered and joined.

3.3 Participants

The participants of this experiment were 18 postgraduate students (12 male, 6 female) studying for a degree in Business Systems Analysis and Design. The participants were granted anonymity. The participants were randomly and equally assigned to either the control group or the experimental group. The participants in the experimental group were again randomly assigned into one of three groups. These groups of three, or triads, competed against each other in the game.

3.4 E-Learning Content

Each participant played two games, each having different questions. Two domains were studied. Biology (participants had no prior knowledge) and ASP (Active Server Pages) language programming (participants had prior knowledge). The first game that the participants played had biology questions. These biology questions were taken from a GCSE (General Certificate of Secondary Education) syllabus. The second game played had computer programming related questions, in particular questions relating to the scripting language ASP. The questions were modified from an e-learning website.

3.5 Learning Improvement

The dependent variable of the research question is "learning improvement". This is a notoriously hard variable to measure. Ahdell and Andresen [18] note how difficult

this is in relation to corporate GBEL. The most common way that teachers and trainers use to see if there has been some kind of learning improvement is with tests and examinations. This is the easiest and most efficient way to see if the game has had any effect on the student and to gauge if anything has been learnt.

To examine learning improvement, the participants completed two pre-game questionnaires. The pre-game questionnaires were designed to capture the prior knowledge the participants had on the particular topics. The questions used in the pre-game questionnaires were the same questions that were later used in the game. The questionnaires contained 15 questions: 8 questions were multiple-choice and 7 were open-ended questions. The questionnaires were marked and each participant was given two scores out of 15, one for biology and one for ASP.

After the games were played by the participants they were asked to complete two post-game questionnaires. One questionnaire featured the same biology questions as the pre-game questionnaire, and the other featured the same ASP questions as in the pre-game questionnaire. These two tests were also marked and each participant was given two scores out of 15, one for biology and one for ASP.

One week after the experiments were performed the participants were asked to complete two pp (post-post) questionnaires, again one with the same biology questions as the pre- and post-game questionnaires, and one with the same ASP questions as the pre- and post-game questionnaires. The purpose of the post-post questionnaires was to measure retention of learning improvement.

3.6 The Experiment

The experiment was conducted under laboratory conditions. Before taking part in the experiment each of the participants was required to sign a consent form. Each participant went through the same procedure during the experiment: The schedule for the experiment was as follows: (1) Pre-game Biology Test; (2) Pre-game ASP Test; (3) Five minute rest; (4) Play Biology game; (5) Play ASP game; (6) Five minute rest; (7) Post-game Biology quiz; (8) Post-game ASP quiz.

The participants were all read the same script and given the same instructions. The only difference in the testing procedure was between the control group and the experimental group. The experimental group participants were told that they were playing the game in competition with the other members. They were told that the purpose of the game was to win, and this could be achieved by being the first person to answer correctly 15 questions in a row. The control group participants were told that they were playing the game on their own, and that there was no competition with the others in the test scores.

4. Results and Analysis

This section discusses the results of the experiment. These results are examined in comparison with the project objectives and the wider perspective of theoretical and applied work relevant to the project. To check for any

differences between the two groups in their prior knowledge in the two domains (Biology and ASP) two separate initial t-tests were carried out. Both the t-test between the prior-knowledge of the experimental and the control group for Biology ($t(16) = 0.837$, $P > 0.05$) and that for ASP ($t(16) = 2.11$, $P > 0.05$) proved that there were no statistically significant differences between the control and experimental group.

4.1 Effectiveness of Competitive Learning

Two t-tests were carried out to test for any statistically significant difference in learning due to playing the game in a competitive or a non-competitive context. This was carried out by comparing the differences between the post- and pre-questionnaire results. For the Biology ($t(16) = -3.74$, $P < 0.05$) game it was found that the learning improvement in the competitive context was significantly lower than that of the non-competitive context. But for the ASP ($t(16) = -1.25$, $P > 0.05$) game no significant differences were identified.

4.2 Retention of Learning

Two additional t-tests were carried out to test for retention of learning in competitive and non-competitive context. This was carried out by comparing the post-post and pre-questionnaire results for the two domains. For the Biology ($t(16) = -3.74$, $P < 0.05$) game it was found that the learning retention in the competitive context was significantly lower than that of the non-competitive context. But for the ASP ($t(16) = -1.25$, $P > 0.05$) game no significant differences were identified.

4.3 Average Improvement in Learning

An additional t-test was carried out to address the above-mentioned differences in the results from the two domains. This was done by combining the findings of the Biology and the ASP tests. It was found that the learning improvement in the competitive context was significantly lower ($t(16) = -2.91$, $P < 0.05$) than that of the non-competitive context.

5. Discussion

Our results indicate that competitive approach in GBEL fails to achieve a better learning improvement and learning retention among the students despite some believes that competition provides a motivational factor to learn. It is even more evident in the case where students have no prior knowledge on the target domain. It is worth mentioning that the computer game used in this experiment was designed to provide extrinsic motivation where the game activity is not tightly linked to the learning process.

Intrinsic motivation in computer games which relies on the understanding of the subject matter from within the game world is not tested in this study and might yield an interesting result thus enlightening our theoretical understanding on goal structures and competitive learning.

There are some limitations of this study. For instance the sample size of the study was rather small to yield a more significant result. In addition, the uneven distribution of the background and the gender might also affect the finding of the study.

Therefore we would like to suggest some possible future studies in this area. Further research should be conducted using different competition styles in games. Although the results of the experiment are statistically significant, running additional longer studied with a bigger sample size might provide a more solid validation of our findings.

It would be also interesting to see if the results would be different with participants of various age groups. A useful test might be between children and adults, or children of different ages.

Further research should be carried out using a wider variety of games and with a wider spectrum of participants. The games used in this project could be used on a wider spectrum of participants. Moreover, it might be useful to relate inter- and intrapersonal competitiveness index and learning improvement.

This study also gives an implication to designing GBEL especially for school uses. Practitioners, such as designers of e-learning applications, should look closely into the role of competition in GBEL. It should be remembered that in this study competition was a hindrance to the learning process. We must be aware that there are a number of ways to structure competition in a game, which have not been tested yet in this study.

6. Conclusion

The research question was fully addressed and answered. This was achieved by conducting a thorough literature review and an experiment. The literature revealed that, there has been much research into the use of competition in conventional teaching, although competitiveness in GBEL is underexplored.

It is important that developers and users of GBEL be aware of the effect that competition has on playing the games. This study indicated that when playing an e-learning game the learning effectiveness will be lower if that game is played in a competitive context rather than a non-competitive, individualistic context. It should be remembered though that this study indicates that certain types of competition worked at that time in those circumstances. Future studies into the effect of competition in game-based learning should be conducted using a wider variety of games with a wider spectrum of participants.

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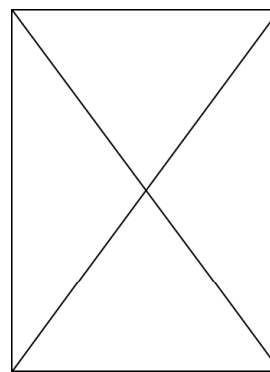
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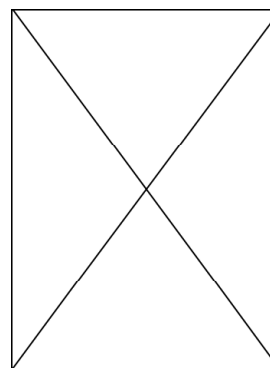
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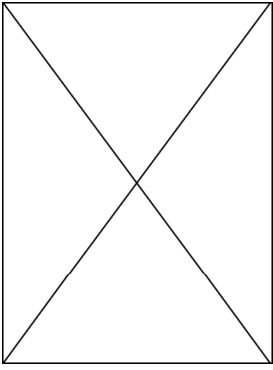
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