WIP: Using a Computer Gaming Strategy to facilitate Undergraduates' Learning in a Computer Programming Course: An Experimental Study

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Abstract - **This study implemented and evaluated an educational computer game as a supplemental instructional method in a fundamental computer programming course. Twenty undergraduates who enrolled in a fundamental computer programming course for non-computer science majors participated in the study. They were randomly assigned to use one of two different supplemental instruction delivery methods for a three-week period of instruction. One group used an electronic quiz program and the other group used an educational computer game. Both methods used the same set of quiz bank and all quizzes were selected randomly by the applications. After the instructional treatments were implemented, students' intrinsic motivation and final achievement scores were measured and analyzed. The result of the study indicated that students in the treatment group had positive attitude toward the educational computer game. Specifically, the students in the educational computer game group demonstrated higher intrinsic motivation and better achievement scores compared to the students in the control group.**

Index Terms - Educational game, Intrinsic motivation, Supplemental instruction, Computer science education.

INTRODUCTION

Using educational video games (or serious games) is among the uprising strategies being used as motivational tools to enhance students' computer programming ability in computer science education. Studies indicated that educational computer games were effective tools for motivating students' learning in many areas [1-2]. Students with higher intrinsic motivation outperformed those with lower intrinsic motivation [3]. This study was designed to compare two different supplemental instruction delivery methods in enhancing learners' intrinsic motivation. One method used a quiz program which randomly selected quizzes from the quiz bank and presented to the students in a way that they would practice what they had learned in the classroom. The other method was to use an educational computer game as a supplemental instructional strategy. The research study was designed to compare their effects on students' intrinsic motivation.

METHODS

- **Students**: Twenty undergraduate students who enrolled in an introductory programming course participated in the study.
- **Materials**: Materials used in the research study were an educational game, a quiz program, the Intrinsic Motivation Inventory, and the Computer Game Attitude Scale. An educational computer game, Capital Tycoon, was developed to facilitate students' newly acquired knowledge. Intrinsic Motivation Inventory (IMI) was used to measure participants' perception of intrinsic motivation on computer programming. IMI is a multi-dimension measurement instrument which contains several subscales. Computer Game Attribute Scale (CGAS) was also used in the post-treatment survey of experimental group for measuring participants' attitude toward computer game. There are two subscales: Liking and Comfort. The alpha reliability coefficients for the scores on the Liking, Comfort, and the total CGAS were .84, .86, and .88 respectively [4].
- **Procedures**: The students were randomly assigned to two instructional treatment groups. The first group used the quiz program and the other one used the Capital Tycoon for three weeks. There were 50 items in the quiz bank when the study started. Both the quiz application and Capital Tycoon needed to be recorded in order to collect data for each session. Because the programs were distributed using Java WebStart™ technology, the most current version would be updated each time when the participants started the program. During the treatment period, the participants used the applications any time they preferred as long as they had a computer with an Internet access. The programs were simply designed for a single user, but they were not restricted to use the program alone. After the three-week period of the experiment, the programs were taken off from the Internet so that the participants had no access to them anymore. An email was sent to all participants informing them that the treatment period was completed and they would start the online survey. The treatment and data collection ended after they finished the online survey.

RESULTS

This study hypothesized that students in the treatment group with a more motivational supplemental instruction delivery method would benefit from the educational computer game. They would demonstrate higher intrinsic motivation than the control group that did not use a game.

The dependent variable of this study was the students' intrinsic motivation scores measured after the treatment was conducted. After the survey was conducted, IMI was measured and calculated by adding all the dependent categories except the pressure/tension score because it was a negative predictor of a person's intrinsic motivation. The result suggested that the students in the treatment group had positive attitude toward the educational computer game. They seemed to enjoy the educational computer game and also felt comfortable about their gaming experience. The means and standard deviations of dependent measures showed that there were differences between the control and the treatment groups in five different categories and IMI overall scores (see Table I).

TABLE I
MEANS AND STANDARD DEVIATIONS OF DEPENDENT MEASURES

Dependent Measures	Gaming (N=9) M/SD*	Non-gaming (N=11) M/SD*
Interest/Enjoyment	33.22/2.74	25.09/3.06
Perceived Competence	28.11/3.55	23.91/3.11
Effort/Importance	26.44/2.16	25.55/1.72
Pressure/Tension	15.89/2.97	17.00/2.39
Value/Usefulness	29.78/2.65	23.36/2.67
IMI Total	141.67/8.30	120.91/8.45

*M: Mean; SD: Standard Deviation

The alpha level of .05 was set for the follow-up independent t-test analysis. The result showed no significant differences in all five categories and overall scores. However, in interest/enjoyment, value/usefulness, and overall scores, it was approaching statistical significant difference, especially in the measure of interest/enjoyment (p=0.069).

CONCLUSIONS

The result of the study indicated that the dependent measures of interest/enjoyment, perceived competence, and overall IMI scores were improved in the gaming group. Similar results can be found in Klein and Freitag's study [5] that gaming strategies were used as an instructional method to increase students' motivation. They used an instructional card game instead of educational computer game in enhancing students' motivation toward the content area. In their study, however, there was no significant difference in students' learning performance.

During the experiment of the current study, the students were given the same allotted time for both control and treatment groups. The students in the gaming group seemed to spend more time on learning gaming strategies instead of the instructional materials than the control group.

Although the sample size in the study was small (control and treatment groups, 11 and 9 respectively), the effect sizes in some of the categories were promising. According to Cohen's study [6], with the effect size of .81 in interest/enjoyment, the mean of gaming group is at the 79th percentile of the nongaming group; and for IMI overall, the mean of gaming group is at the 77th percentile of the nongaming group. Therefore using the gaming as a tool for instructional strategy may have some promising practical values to instructional designers and educators. The reason for a low effect size in the measures of effort/importance and pressure/tension (0.22 and 0.20 respectively) may be due to the fact that many of the participants were information science and technology (or computer-related) majors. They might have already built up their own learning strategies in computer programming prior to the experiment. The educational computer game did not influence their views on those dependent measures.

The further study should compare the retention rate of both groups because there were some students who switched to the non-computer-programming major after taking one semester of computer programming course. To provide better insights for computer programming educators, future research should also need to recruit more students to participate in the study.

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