McSTEP: Metacognition Self Test with E-Prime Project

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Abstract

E-Prime and AutoIt software were used gamify quizzes in a research design and statistics course. The McSTEP game (Metacognitive Self-Test with E-Prime) incorporates choice of difficulty level, thresholds for the next stage, multiple attempts at an item and immediate performance feedback. After overcoming many technical challenges three significant changes in metacognition showed that students perceived themselves lower in planning, evaluation and monitoring at the end of the spring semester. Analysis of the students' game behaviors showed patterns consistent with different metacognitive strategies, such as distributed practice each week to monitor and evaluate learning vs. cramming the game before the recording deadlines.

Introduction

Metacognition is the term used by Flavell (1979) to refer to thinking about thinking. Modern theories of metacognition are divided into three areas; these are knowledge about what we know (content) and how we know it (process) and the knowledge of how to regulate our own learning (Coutinho, 2006)). Undergraduates learning a new and difficult cognitive domain such as research design and statistics seem to vary in their metacognitive skills. Some use self-testing, such as online quizzes, as an opportunity to assess how well they understood the textbook content and whether their study strategies are working. However, many students seem to take quizzes as just another task that must be completed, preferably with as little mental effort as possible, to obtain the desired score. Their mindsets do not connect their learning outcomes to their study strategies (Dweck, 2010).

Many undergraduates spend hours of study to improve their knowledge and skills of specialized domains such as the World of Warcraft, Minecraft, Farmville, and other computer-based games. Such games provide individual performance feedback, often in multiple forms, rewards, and in many cases, social connectivity. Gamification is the application of the methods of computer gaming to other learning domains. This poster presents two semesters of transition from a typical online quiz format to a game format, Metacognition Self Test with E-Prime (McSTEP).

Teaching Application

In order to gamify the quizzes, several changes in normal quiz procedures were incorporated. First, students select a difficulty level. The easy level, which corresponds to a novice level in a game, has basic definitional and knowledge questions. The application questions are in the medium level and the advanced level includes interpretation questions. Students receive more points per question based on the difficulty chosen. Second, students may attempt each question until they answer it correctly. They receive more points for getting the question right on the first try. This not only gives the students immediate feedback, but motivates them to go for their second guess if their first was not correct. Third, students get to play the game until they reach the performance level they desire. Fourth, students may not go on to the next phase of the game (next chapter of the text) until they reach a minimum threshold level of performance for the current phase. These features mimic popular video games and they also have benefits for increasing metacognitive awareness.

Technology Issues

The computer software used for this project was a combination of E-Prime and the freeware automation script program AutoIt. The McSTEP game was networked through our campus' domain network. Students were able to play the game on any computer in the research design and statistics lab as their network login generated all the information needed to initiate locating the correct information. E-Prime was selected as the main quiz delivery system because it allows for close scrutiny of the students' quiz applications across the semester, measuring the amount of engagement with the game by difficulty level, and number of retakes. The framework to provide feedback was more difficult and required a set of programs that get the student's gamer tag, find the last cumulative score, allows the student to select a difficulty level, checks to see that the student has completed the previous game phases (passed previous chapter), records the score and provides social feedback. To our knowledge, no one has applied the E-Prime program for a gaming application or in a manner that directly takes E-Prime generated data as input into other networked programs.

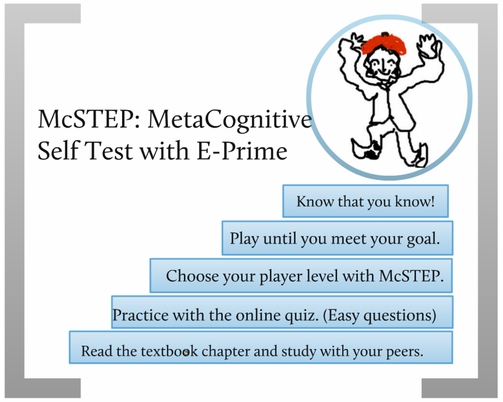


Figure 1. McSTEP process introduction for students.

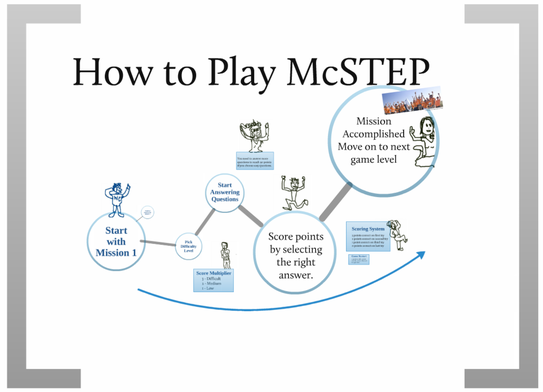


Figure 2. McSTEP game rules introduction for students.

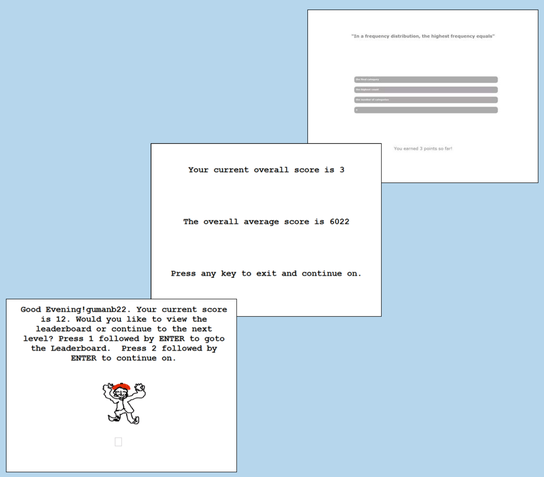
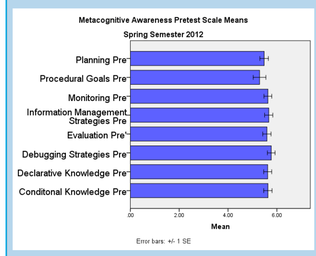
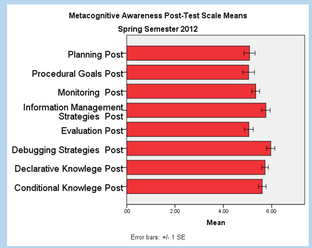


Figure 3. Screenshots from the McSTEP game.

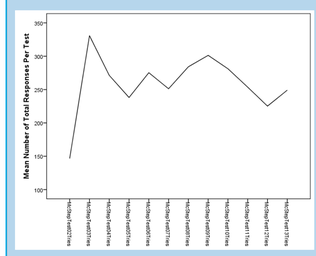
Metacognition

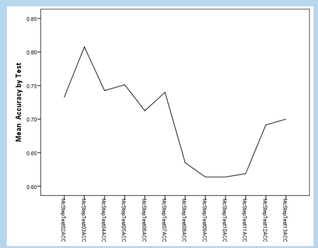


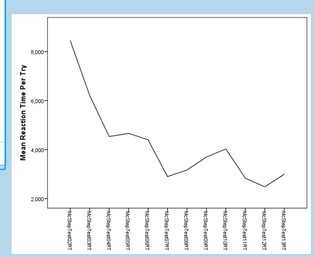


Figures 4 -5. Students began the semester with high self perceptions of their metacognitive skills and ended the semester slightly lower on the planning, monitoring and evaluation scales.

Game Engagement

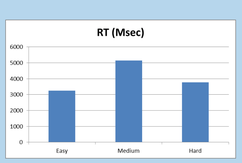


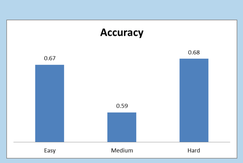




Figures 6-8. Student engagement in terms of amount of tries for each game level increased initially and then leveled off. Accuracy decreased for chapters 8-11 (ANOVA) while time per question decreased over the term.

Difficulty Level





Figures 9-11. Students tended to choose difficult questions, they performed at about the same accuracy and speed for easy and hard items. Accuracy was lower and time higher for medium items. This was also true for 10 of the 12 students who select both medium and hard items.

Preliminary Evaluation

The initial startup was rocky because of problems involving the gamertag which serves as an ID for each student. Students who chose to use their campus network user names as gamer tags could not play the game because of a system conflict. This also defeated the purpose of keeping the student's score anonymous to others. The quiz delivery system through E-Prime worked well. The framework to check phase level and report points before and after the quizzing did not perform well at first. Students worked with the authors to identify the bugs in the program. It was not possible to fully test the programs before the semester began because the main issues are network problems that arise when multiple users are playing the game simultaneously. One benefit of the debugging process is that students can see the realities of data collection, even in the game context. Students in this course also use E-Prime to complete labs on measurement and design, so their greater familiarity with the program was a plus. In addition, they could see the programmers model problem solving as they identify the problems, choose solutions and apply them.

Assessment

The assessment plan included measuring students' engagement with McSTEP throughout the semesters, and a pretest and post-test on metacognition. All students completed 17 items from a goal orientation inventory (Roedel & Schraw, 1994) and metacognition awareness inventory (Schraw & Dennison, 1994) that measure their perceptions of how they learn at the beginning and end of each semester. The post-test was not administered during the fall semester because the network failures prevented completion of the project. Students in the spring semester completed the pretests and post test metacognitive assessments. Analysis of the scales produced from these inventories showed that most students began the semester with a very high level of perceived metacognitive awareness. The possible range of scores was 1 to 7, and the means for the scales were all above 5 (see Figures 4 and 5). By the end of the semester student perceptions remained high with only three of the subscales showing a significant change, and each of those was in a negative direction (planning ($t(21) = -2.24$, $p = .036$), monitoring ($t(21) = -2.58$, $p = .017$) and evaluation (t (21) = -2.92, $p = .008$)). However for each scale the change was from average rating between agree a little and somewhat agree (M = 5.5) to closer to agree a little ($M = 5$). Student engagement with the game during spring semesters is shown in Figures 6-8. Students did engage consistently with the game across the semester. There speed of response increased but their accuracy did not increase over time. Figures 9-11 show results of student selection of difficulty levels. Most students chose to play the game at the most difficulty level. They were most accurate and fastest with the difficult and easy game levels.

Next Steps

So far the game shows a good engagement for some students, but many students seem to cram the game the same way they cram studying. Next semester a new method of encouraging the game play before each chapter is covered in lecture will be used. A health bar which ends the game for too many guesses and better overall class feedback should improve the game. Finally, a better method of measuring metacognitive development will be used. This method seemed to have too many high scores at the pretest level, reflecting either students with high metacognitive self awareness or social desirability effects.

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