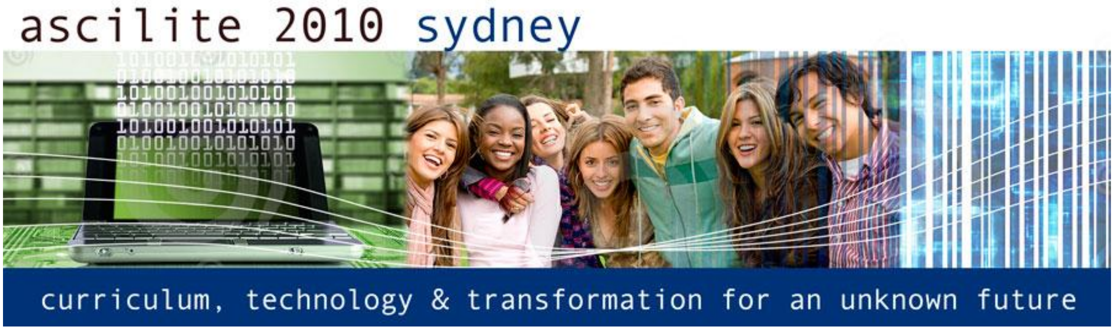

Using an educational game to learn – are there any gender differences between pre-service teachers?

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This article discusses an exploratory study that aimed to examine the gender differences between female and male student teachers who played an educational game to learn programming concepts. In this study, we adopted a self-made educational game called "Simulator". Eighteen females and fifteen males have finished playing a level of the Simulator. Female participants spent more time in the Simulator but their scores were lower. The findings call for larger and longer research studies and perhaps a re-design of the Simulator to make it more appealing to females when using an educational game to learn programming.

Keywords: Web 2.0, blended learning, pre-service teachers, virtual presentation, peer assessment

Introduction

Computing has long been dominated by men. Indeed, women are more likely to be computer phobic than men (Igbaria & Chakrabarti, 1990; Rosen & Maguire, 1990). Despite the increasing user-friendliness of software and hardware in the past decade, Schumacher and Morahan-Martin (2001) still found that female university students reported higher levels of discomfort with and incompetence in using computers, while male students were more experienced and possessed higher levels of Internet skills. However, Wilson (2002) found that there was no difference between female and male undergraduate computer science students in terms of comfort level and mathematics background, but a significant gender difference was found in game playing, as male students had much more experience in this area.

Most popular video games are primarily targeted to young male players and contain male protagonists (Beasley & Collins Standley, 2002), with many of the action games not appealing to girls (Quaiser-Pohl, Geiser, & Lehmann, 2006; Terlecki & Newcombe, 2005). Generally, boys spend much more time playing video games than girls (Cherney & London, 2006; Lucas & Sherry, 2004). In a survey of high school students conducted by Chou and Tsai (2007), boys reported spending more time playing computer games than girls, were more motivated, and enjoyed computer games more. In fact, boys and girls have different preferences and designed very different games in terms of the game nature, spaces, characters, interaction, and feedback (Kafai, 1996).

While there have been many studies on the usefulness of computer games for learning, much of the research on gender differences has focused on spatial attention (Green & Bavelier, 2003; Feng, Spencer, & Pratt, 2007). Bryce and Butter (2002) reviewed research related to gender and gaming and found much of the discussion to be related to the content of the games rather than on the analysis of female and male gaming experiences. This study sets out to investigate whether there are any differences between female and male students when using a particular educational game to learn programming.

The study

In order to enhance pre-service teachers' programming skills, a self-developed educational game, the Simulator, was developed. The rationale for designing the Simulator was that most pre-service teachers

were rather weak in programming skills and this was not unique to the author's classes (Feldgen & Clua, 2004). The design of this game followed the rationale of Logo, which was intended to provide children with a new way of "playing" with (and learning) mathematical ideas by controlling a turtle's motion (Papert, 1980). The simple Logo commands also enabled players to learn programming concepts more easily. The main objective of this study was to investigate whether there were any differences between female and male pre-service teachers when using this educational game to learn programming.
Two hypotheses were formulated to answer the research question:

H1: There is no difference between male and female players in their mean gaming score.
H2: There is no difference between male and female players in their mean gaming time.

The participants

A group of 33 pre-service teachers participated in this study. The participants were students minoring in information technology who had studied Logo programming during secondary school or in the course of their university education. The participants were familiar with the Truth Table in the programming module that they took with the author. They were told that the Simulator would help solidify their programming and control technology concepts after a few weeks of classes. After a brief introduction to the game, they were asked to play it during their leisure time, an activity that would count as part of their class participation grade regardless of their performance. The students recorded their entire playing process in digital video files (wmv file format), which, upon completion, were uploaded to a dedicated server area.

Tasks

The participants were asked to guide a small plane in the Simulator to a destination denoted by a red tile. The stages were grouped into three levels: beginner (Stages 1-4), intermediate (Stages 5-7), and advanced (Stages 8-10). The beginner level introduced players to the gaming environment. In the intermediate level, players were required to tackle three dimensional (3D) movements such as guiding the plane to retrieve a ball placed on a different level. In the advanced level, players were expected to consolidate the concepts and skills they had acquired in the first two levels; however, they were required to use the concepts of logic gates such as "or," "and," and "not" to guide the plane through various hurdles.

At first glance, the Simulator appears to be an action game but in fact it is a strategy game. As the stages become more complicated, players should become aware of the different strategies involved in completing a task. This variation affects the number of scripts used and the distance the plane travels, which is similar to composing the scripts when programming. The player has to decide how to guide the plane to the red tile by employing appropriate actions and units. Take Figure 1, Stage 1, as an example. When the game starts, the plane faces north, with at least two possible routes to arrive at the red tile. The traveling distance is the same between Route 1 and Route 2. However, a higher score will be obtained if the player chooses Route 1, as Route 2 requires one more script. For Route 2, the plane has to "Turn Right 90 degrees" before proceeding to the other movements; that is, move Front 600 units (100 Units is equivalent to 1 tile), Turn Left (Turn Right for Route 2) 90 degrees, and Move Front 600 units to reach the red tile. The plane does not have to "Turn Right 90 degrees" if the player uses Route 1 as a strategy.

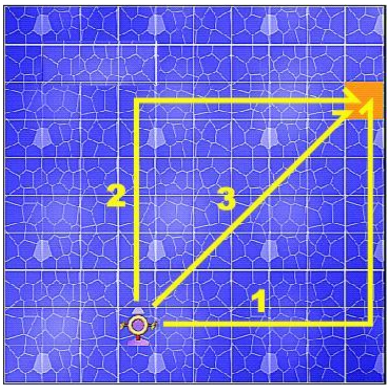

Figure 1: Scene of Stage 1

There are other possible solutions for the plane to arrive at its destination in addition to Route 1 and Route 2. The best solution is to manipulate the plane to turn right 45 degrees and then move diagonally (Route 3) to the destination. To do this requires knowledge of some mathematical theories, such as the Pythagorean Theorem, in order to find the shortest distance to the destination, which is the aim of learning Logo programming. This example shows that in the early stages of the game, there are many possible routes, and players can easily identify many more routes in later stages of the game when the plane has to escape from obstacles in 3D environments and solve problems using knowledge of logic gates. Figure 2 shows a Stage 9 scene, which aims to complete the logic circuit by bringing appropriate binaries on the red tile. A good understanding of control technology is required to tackle this task. After completing a stage, the Simulator will calculate the score based on the distance travelled by the plane and the number of scripts selected. The shortest distance and fewest steps taken to get to the destination will yield the highest score.

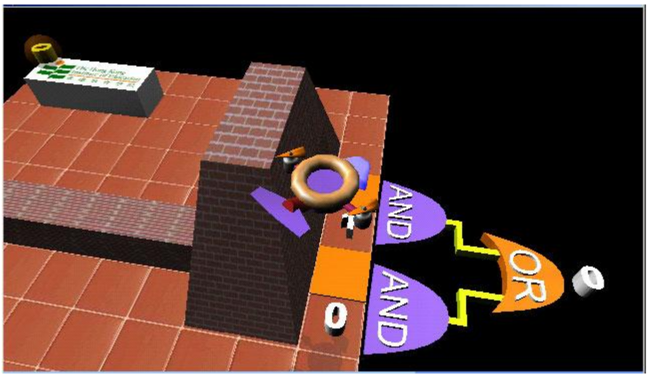

Figure 2: Screen shot of Stage 9

Findings and discussion

To answer the research question – are there any gender differences between female and male pre-service teachers when they use educational games to learn programming concepts? – video recordings of game playing performances were viewed and analyzed by a research assistant. Fifteen male and 18 female players completed at least one level (3 stages) of the Simulator. A total of 45% of the students completed the beginner level, while 30.8% and 24.2% respectively completed the intermediate and advanced levels.

Score

The mean score for all participants was 8582.41 with the mean scores for male and female players being 9491.88 and 8110.41 respectively. The results of a t-test (p-value=0.025) revealed a difference between male and female players in their mean gaming score at a 5% significance level; thus, H1 was not supported. Perhaps the objects in the Simulator appealed more to male players, as they demonstrated better visual memory of "masculine" and "neutral" items than female players (Ferguson, Cruz, & Rueda, 2008; Kafai, 1996).

Gaming Time

The range of the game time was from 9 seconds to 17 minutes, and the mean of the time that participants spent in each stage was about 2 minutes. At the beginner level, 90.7% of games were completed within 2 minutes, but only 40.5% were completed within this time at the intermediate level. At the advanced level, 55.17% of games were completed within 2 minutes. Stage 5 seemed to be the most difficult, as only 30% of games were finished after 6 minutes. A plausible reason for this was that pre-service teachers needed more time to tackle the 3D challenges at the initial encounter. Table 1 shows that students spent much less time in the following stages, demonstrating that they were able to grasp the programming concept in Stage 5.

Table 1: Frequency of gaming time in each stage

			stage										Total
			1	2	3	4	5	6	7	8	9	10	
dur_range	less than 1 min	Count	16	12	5	2	2	3	1	4	2	0	47
		% within stage	88.9%	60.0%	31.3%	12.5%	20.0%	27.3%	11.1%	50.0%	28.6%	.0%	39.2%
	within 1 and 2 min	Count	1	6	9	4	0	4	1	2	5	1	33
		% within stage	5.6%	30.0%	56.3%	25.0%	.0%	36.4%	11.1%	25.0%	71.4%	20.0%	27.5%
	within 2 and 3 min	Count	0	1	2	6	2	3	1	2	0	1	18
		% within stage	.0%	5.0%	12.5%	37.5%	20.0%	27.3%	11.1%	25.0%	.0%	20.0%	15.0%
	within 3 and 4 min	Count	0	1	0	2	0	1	1	0	0	2	7
		% within stage	.0%	5.0%	.0%	12.5%	.0%	9.1%	11.1%	.0%	.0%	40.0%	5.8%
	within 4 and 5 min	Count	0	0	0	1	1	0	3	0	0	0	5
		% within stage	.0%	.0%	.0%	6.3%	10.0%	.0%	33.3%	.0%	.0%	.0%	4.2%
	within 5 and 6 min	Count	0	0	0	1	2	0	1	0	0	0	4
		% within stage	.0%	.0%	.0%	6.3%	20.0%	.0%	11.1%	.0%	.0%	.0%	3.3%
	more than 6 min	Count	1	0	0	0	3	0	1	0	0	1	6
		% within stage	5.6%	.0%	.0%	.0%	30.0%	.0%	11.1%	.0%	.0%	20.0%	5.0%
Total		Count	18	20	16	16	10	11	9	8	7	5	120
		% within stage	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%

Video recordings showed that male students spent much less time completing the stages than female students. The means of the gaming time for each stage for male and female students were 1 minute 48 seconds and 2 minutes 32 seconds respectively. The results of a t-test (p-value=0.044) revealed a difference between male and female players in their means of gaming time at a 5% significance level; thus, H2 was not supported. It is possible that male students exhibited better spatial attention (Feng et al., 2007; Green & Bavelier, 2003) and had more gaming experience, and that this helped them complete the tasks faster (Cherney & London, 2006; Lucas & Sherry, 2004).

Limitations

This study has a number of limitations of. First, since the students played the game during their leisure time, it is possible that many other factors affected the findings. Second, the findings could be biased because students could submit the playing process of their first attempt or other attempts. Finally, this study was based on a small-scale research sample, so it is inappropriate to generalize the findings.

Conclusion and future research directions

This article discussed the features of an educational game and explored the behavior of pre-service teachers when using it to learn programming concepts. It was found that male and female participants performed differently despite the similarities in their formal education background. Female students spent more time playing the game and yet scored less than their male counterparts. The two formulated hypotheses: H1 (there is no difference between male and female players in their mean gaming score) and H2 (there is no difference between male and female players in their mean gaming time) were rejected. The findings certainly provide concrete evidence that there is a gender differences between female and male pre-service teachers when using an educational game to learn programming.

Two possible directions for further study involve designing educational games to minimize gender differences and conducting research on gender differences. For example, instead of having a default plane, scene, and interfaces, the game could include giving players a choice of more feminine objects, scenes, and obstacles, as the present design is rather masculine and research has found that different genders exhibit different preferences (Kafai, 1996). Alternative choices of objects could be pets, toys, or people; the destination could be a restaurant or a rose garden, and the obstacles could be houses, animals, and trees. Female players might perform better in a more feminine environment as they tend to remember “feminine” objects better (Ferguson et al., 2008).

There are several different approaches that can be taken to conducting research on gender differences in using educational games as a means of learning. First, as it is unclear what factors contributed to the different gaming times and scores, studying the strategies of male and female players might shed some light on these differences. Second, the findings reported here are based on one snapshot study, but they might have been different if the participants had used computer games to learn for a longer period of time, as improvements have been reported when female players engaged in 10 hours of action video games (Feng et al., 2007). Third, given the fact that we do not have many pre-service teachers taking IT as a minor discipline, perhaps we can cooperate with other researchers to conduct larger scale research. Fourth, the results would be more convincing if we could conduct pre-tests and post-tests to determine the effectiveness of using educational games to learn programming. Finally, there is a great need to include some control groups in the research to find out if educational games can help teach programming concepts.

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References

Beasley, B., & Collins Standley, T. (2002). Shirts vs. skins: Clothing as an indicator of gender role stereotyping in video games. *Mass Communication & Society, 5*, 279-293.

Becker, K. (2001). Teaching with fames: The minesweeper and asteroids experience. *The Journal of Computing in Small Colleges, 17*(2), 22-32.

Bryce, J., & Rutter, J. (2002, June). *Killing Like a Girl: Gendered Gaming and Girl Simulators' Visibility* Paper presented at the Computer games and digital cultures, Tampere, Finland.

Cherney, I. D., & London, K. (2006). Gender-linked differences in the toys, television shows, computer games, and outdoor activities of 5 to 13 year old children. *Sex Roles, 54*(9-10), 717.

Chou, C., & Tsai, M.-J. (2007). Gender differences in Taiwan high school students' computer game playing. *Computers in Human Behavior, 23*, 821-824.

Feldgen, M., & Clua, O. (2004, 20-23 October). *Simulators as a motivation for freshman students to learn programming.* Paper presented at the 34th ASEE/IEEE Frontiers in Education Conference.

Feng, J., Spence, I., & Pratt, J. (2007). Playing an action video game reduces gender differences in spatial cognition. *Psychological Science, 18*(10), 850.

Ferguson, C. J., Cruz, A. M., & Rueda, S. M. (2008). Gender, video game playing habits and visual memory tasks. *Sex Roles, 58*(3-4), 279-286.

Green, C. S., & Bavelier, D. (2003). Action video game modifies visual selective attention. *Nature, 423*, 534-537.

Igbaria, M., & Chakrabarti, A. (1990). Computer anxiety and attitudes towards microcomputer use. *Behavior and Information Technology, 9*, 229-241.

Kafai, Y. B. (1996). Electronic play worlds: Gender differences in children's construction of video games. In Y. B. Kafai & M. Resnick (Eds.), *Constructionism in Practice – Designing, thinking, and learning in a digital world*. Mahwah, New Jersey: Lawrence Erlbaum Associates.

Lucas, K., & Sherry, J. L. (2004). Sex differences in video game play: A communication-based explanation *Communication Research, 31*(5), 499-523.

Papert, S. (1980). *Mindstorms: Children, Computers, and Powerful Ideas.* Sussex: The Harvester Press.

Quaiser-Pohl, C., Geiser, C., & Lehmann, W. (2006). The relationship between computer-game preference, gender and mental-rotation ability. *Personality and Individual Differences, 40*, 609-619.

Rosen, L., & Maguire, P. (1990). Myths and realities of computerphobia: A meta-analysis. *Anxiety Research, 3*, 167-179.

Schumacher, P., & Morahan-Martin, J. (2001). Gender, Internet and computer attitudes and experiences *Computers in Human Behavior, 17*(2001), 95-110.

Terlecki, M. S., & Newcombe, N. S. (2005). How important is the digital divide? The relation of computer and videogame usage to gender differences in mental rotation ability. *Sex Roles, 53*, 433-441.

Wilson, B. C. (2002). A study of factors promoting success in computer science including gender differences. *Computer Science Education, 12*(1-2), 141-164.

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