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Who Benefited Most from Game-Based Learning in Special Education Settings?

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Abstract

In this study, we compared special education students based on their functioning levels and gender in order to investigate who benefited the most from game-based learning. The results indicated that the low-functioning group improved significantly in both speed and accuracy when compared to the no-game group. Further, the boys' group increased considerably in speed only while the girls' group did not show a significant difference between the game group and the control group. The implications of this study are discussed in greater detail below.

Need for Study Games are an effective way to educate students with disabilities. Evidence-based research has proven that games have immediate learning effects on students with developmental disabilities. For example in Kwon & Lee's (2016) study, game play of simple vocational tasks in a simulated environment positively affected actual hands-on performance of the same task in terms of speed and accuracy. Another study we conducted with children with disabilities showed that playing a self-hygiene game immediately increased self-hygiene behavior, in this case, washing hands (Kim & Kwon, 2014). In our study of mobile math games, we found that playing these types of games increased math achievement and motivation (Shin & Kwon, 2014).

We believe the aforementioned studies were successful because the disciplines of special education have a great deal in common with digital games. Many strategies used in games originate from behavioral and cognitive psychology, which is heavily rooted in the teaching and learning strategies used in special education. For example, one of the prominent aspects of games is the use of rewards for successful completion of a task. Games use points, items, coins, and similar rewards to motivate the person to continue playing. Similarly, the use of behaviorist strategies has shown strong effects for students with various disabilities in special education. Some examples of reward systems include Applied Behavior Analysis (ABA), token economy, and time-out procedures (Anderson, Marchant, & Somarriba, 2010).

Games also use repetition as one of their main methods of play. The player can try challenging tasks through repetition, explore new ways to solve a problem, and even repeat the task after succeeding just to achieve mastery. Repetition is known to be the strongest factor for retention (Hintzman, 1976), and one of the most important methods for increasing learning amongst people with developmental disabilities;

especially those who have difficulty with long/short term memory (Turnbull et al., 2012). Children with developmental disabilities can achieve mastery of tasks through repetition, and can reduce the short-term cognitive load by automating the skills (Sweller, 2003).

Games often tell a story at the beginning to immerse the player into the virtual world. Then, new stories are created by the player as the game continues. These narratives can reduce the cognitive load thereby freeing up more space for learning (Park & Jin, 2006). In special education, it has been demonstrated repeatedly that providing context motivates learners since context conveys meaning to the students (e.g., Bottge, 1999; Goldman & Hasselbring, 1997). Therefore, when students find the problem meaningful, their motivation to learn and ability to solve complex problems greatly increases (Bottge, 1999).

The aforementioned research was part of an original study that was recently published (Kwon & Lee, 2016). In the original research, we inquired whether playing the target game affected the performance of the target task. The results indicated that playing Game A only affected Task A but not Task B and vice versa. In this study, we took a deeper look into the effects of games on students with disabilities. Primarily, we wanted to know which ability groups and genders benefitted the most from the game-based learning.

Understanding the impact of games on specific groups is important for several reasons. First, at the current stage, we do not yet know for whom this new mode of learning is most suitable. Understanding who benefits most from game play can assist teachers in preparing to meet the needs of their individual students since all students learn differently. In the case of special education, the variation of each individual's functioning level varies widely, which requires the teacher to individualize education for each student. By understanding who can benefit most from games, teachers can more efficiently use their resources. Second, from the developer's point of view, it is critical that game designers understand the various intellectual levels of the audience. An effective and entertaining game has good difficulty control and progression into the higher stages of game play. This is important considering that a group of students with developmental disabilities can vary widely in their range of cognitive functioning levels as well as their behavioral characteristics. Although universal design principles should always be applied in game design, sometimes it may not be possible to include audiences from all levels. The knowledge of who benefits most from learning games could help the designer optimize game objectives and difficulty.

Method

Participants

A total of 45 students with developmental disabilities participated in the original study. The participants were randomly assigned to one of the three groups: Control group, Game 1 group, and Game 2 group. The Game 1 group had 15 students while the other two groups had 16 students each. The average age was 16.69(SD=.87) for the Control group, 16.67(SD=.62) for the Game 1 group, and 16.67(SD=1.11) for the Game 2 group. Based on teacher input, students were categorized as high, moderate, or low-functioning before randomization and were assigned to one of the three groups within the ability groups. As a result, for the Control Group (n=16), 50% of students were high-functioning (n=8), 31% were moderate-functioning (n=5), and 18% were low-functioning (n=3). For the Game 1 group, 47% were high-functioning (n=7), 33% were moderate-functioning (n=5), and 20% were low-functioning (n=3).

For the Game 2 group, 50% were high-functioning (n=8), 31% were moderate functioning (n=5), and 18% were low-functioning (n=3). In general, high-functioning means the student can function with more independence while low-functioning would mean the student functions with less independence in school and daily life.

Research Design

A crossover design with control group design was used in the study. This research design was utilized because, in the original study, we were interested in the treatment effects of games on the performance of tasks. All three groups took three rounds of hands-on task tests. After the first round of testing, Group 1 played Game A while Group 2 played Game B. Then, after taking the second round of tests, Group 1 played Game B and Group 2 played Game A. Finally, the participants took a third round of testing. The Control group took the tests but did not play the games in order to control the effect of repetitive testing for later analysis.

Settings & Games

One classroom was set up as a testing station while another classroom was used as a game station. Each student was called individually to the room to participate in the study. Students went back and forth between the rooms to take the test three times, and play the game in between the tests. The game used in the study was Adventures on Coolong Island, which was developed by the researcher as a serious job-training game for students with developmental disabilities. It transformed a basic job-skills textbook into a simulation game. Out of the eight mini-games, two games were selected for study; the *Apple Packaging Game* (Game A) and the *Hydroponics Game* (Game B). Testing consisted of actual hands-on task performance. Therefore, all students took two tests in each test wave: the Apple Packaging performance test and the Hydroponics performance test. In the original study, we wanted to know whether the Apple Packaging Game affected the actual performance of apple packaging, or if the Hydroponics Game affected the actual performance of hydroponics.

Data Collection

Data were collected through observation at the testing station. Time to complete the test was measured for speed data, and the number of errors was counted for accuracy. To ensure reliability, all testing procedures were recorded so they could be analyzed later by a second researcher. In the original study, the reliability was reported to be 97.62% for accuracy and 96.43% for speed.

Data Analysis

For the purposes of this study, we collapsed some data into the following categories:

1. Test waves: Although the data was collected at three time points, for the purpose of this study, only the pre (1st wave of testing) and post (3rd wave of testing) test results were used for analysis.

2. Experimental groups: For statistical purposes, we collapsed the two lower groups (moderate and low functioning) resulting in two groups (high and low) in our analysis. Two game groups were collapsed as well to compare the effect of gaming versus no gaming. ANOVA was used for all analysis.

Further, in the original study, the effects of two games on two tasks were studied. However, the results from the original study indicated that Game A, the easier of the two, showed ceiling effects which compromised the results. Therefore, in this analysis, we excluded Game A and only included Game B.

Results

High-Functioning versus Low-Functioning

The means, standard deviations, and gain scores of pre and post-tests for speed and accuracy are described in detail (see Table 1). Within each experimental condition, we compared the effects of gaming on high and low-functioning groups in comparison to the Control Group of a similar functioning level. One-way ANOVA results indicate that, for the high group, significant differences were not found for speed ($F(1, 20)=1.153$, $p>.05$) or accuracy ($F(1, 20)=4.356$, $p>.05$). However, within the low group, significant differences existed for both speed ($F(1, 23) = 16.041$, $p=.001$) and accuracy ($F(1, 23)=4.773$, $p=.039$).

		High (N=22)				
		Pre		Post		
		M	(SD)	M	(SD)	Gain
Speed						
	Control	0.070	(0.011)	0.072	(0.025)	+0.002
	Game	0.069	(0.034)	0.084	(0.036)	+0.015
Accuracy						
	Control	13.462	(0.576)	13.327	(0.557)	-0.135
	Game	13.210	(0.860)	13.354	(0.546)	+0.144
		Low (N=25)				
		Pre		Post		
		M	(SD)	M	(SD)	Gain
Speed						
	Control	0.035	(0.030)	0.033	(0.029)	-0.002
	Game	0.037	(0.026)	0.047	(0.031)	+0.010*
Accuracy						
	Control	8.077	(6.688)	8.077	(6.688)	+0.000
	Game	8.481	(5.962)	10.500	(4.792)	+2.019*

*p<.05

Table 1. Pre and post results comparing high-functioning and low-functioning students.

Boys versus Girls

The means, standard deviations, and gain scores of pre and post-tests for speed and accuracy are

described below (see Table 2). Within each experimental condition, we compared the effects of game playing on the boy and girl groups in comparison to the Control Group of the same gender. The one-way ANOVA results indicate that, for the boys group, significant differences were found for speed ($F(1, 35)=5.703$, $p<.05$) but not for accuracy ($F(1, 35)=3.899$, $p>.05$). For the girls group, the Kruskal-Wallis test (a non-parametric equivalent to one-way ANOVA) results show no significant differences existed for both speed ($\chi 2$ (1)=1.636, $p>.05$) or accuracy ($\chi 2$ (1)=1.481, $p>.05$).

Boys (N=37)					
	Pre		Post		
	M	(SD)	M	(SD)	Gain
Speed					
Control	0.053	(0.029)	0.048	(0.027)	-0.005
Game	0.047	(0.032)	0.055	(0.037)	+0.008*
Accuracy					
Control	10.769	(5.341)	10.671	(5.286)	-0.098
Game	10.726	(4.881)	12.471	(2.796)	+1.745

Girls (N=10)					
	Pre		Post		
	M	(SD)	M	(SD)	Gain
Speed					
Control	0.051	(0.029)	0.061	(0.046)	+0.010
Game	0.075	(0.029)	0.093	(0.024)	+0.017
Accuracy					
Control	10.769	(6.044)	10.769	(6.044)	0.000
Game	10.949	(5.381)	12.115	(3.845)	+1.167

*p<.05

Table 2. Pre and post results comparing boys and girls.

Discussion

From the results, it is evident that participants in the low-functioning group benefited from the games while the high-functioning group did not show a significant difference from the Control Group. The low group increased in both speed and accuracy for the given task. Lower-functioning students typically have a shorter attention span, difficulty remembering information, and a lack of motivation to learn. These low-functioning students will benefit from the immediate feedback, narrative, and motivating qualities of game play while high-functioning students may learn well in both traditional and game media. Therefore, using games for teaching and learning activities will be more effective for students with lower-abilities in special education. This data, in accordance with other educational technology studies, demonstrates that a technology-enhanced curriculum is effective for assisting low-achieving students become high-achieving (Bottge et al, 2001; Bottge et al, 2007). Therefore, one can conclude that digital media is an effective tool to help students visualize, simulate, and focus on problem solving.

When comparing gender, the results indicate that boys gained task completion speed but not accuracy when compared to those who did not play the game. On the other hand, girls did not show significant gains in either speed or accuracy when compared with the no-game group. However, we must take caution when interpreting the girls' results because the data was too small (n=10) to be reliable. When investigating the gender effect, recent game studies showed no significant differences in achievement

between boys and girls (e.g., Annetta et al, 2009; Ke & Brabowski, 2008; Papastergiou, 2009); however, those studies did not examine speed to completion. In our observation, after playing the game, participants perceived the test as a game situation and tried to finish as soon as possible. Such transfer of perception from game to the real world may have been in effect, and perhaps more evident in boys. These findings yield for further studies with larger N's.

These aforementioned findings have several implications for teachers and game developers. For teachers, we recommend that game-based learning activities take low-functioning students into account since they will benefit the most from using the program. For developers, we suggest meeting the needs and levels of low-functioning players when designing various aspects of the game such as difficulty, speed, user interface, and content. Since students with severe disabilities were not included in the study, low-functioning would mean moderate disabilities in a real special education classroom. In this study, each participant only played the games for a total of 30 minutes. The fact that such significant effects were found after such a short period of time is meaningful for special education research. Further studies to confirm the findings of this study will be needed, but our results yield many hopes for the use of games in special education.

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