Educational Equity Using Computer-Assisted Instruction

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Abstract: Technology is increasingly playing a role in the education of early learners. As such, it is vital that research demonstrates that the new suite of tools that are enabled by emerging technologies are both engaging and effective for all students. The Waterford Early Reading Program, a computer-assisted adaptive curriculum, was administered to kindergarten and first grade students enrolled in a South Carolina public school district during the 2016-2017 school year. Analysis of gains made in literacy skills from the middle of the school year to the end of the school year indicated a significant positive effect for students in kindergarten and first grade. Analysis of end of year scores while controlling for middle of year scores showed similar evidence of the efficacy of the curriculum for students in kindergarten and first grade. Examination of available demographics indicated that students of all genders and ethnicities benefitted from the curriculum.

Introduction

Computer-assisted instruction (CAI) is the presentation of different forms of educational media material in an interactive, instructional way. While teachers conduct large group instruction meant for many students to learn a subject, CAI allows individual students to take control of their learning which increases students' flexibility, interactivity, and engagement (Jethro, Grace, & Thomas, 2012). According to research of CAI in the classroom setting, early childhood instruction using CAI can improve literacy performance (Saine, Lerkkanen, Ahonen, Tolvanen, & Lyytinen, 2010; Stetter & Hughes, 2010) in comparison to a typical public classroom setting. Technology, if implemented correctly, can customize learning to suit the level of the learner (Jethro, Grace, & Thomas, 2012). Additionally, CAI has been found to increase the enthusiasm for learning in early readers, present material with animation and immediate feedback, and individualize the learning process (Flewitt, Messer, & Kucirkova, 2015).

Increasingly the question is not about the collective efficacy of these tools but about the equity with which they are employed (U.S. Department of Education, Office of Educational Technology, 2017). Equity of meaningful access to educational technology is not a strictly local issue; this is a phenomenon that is being felt and addressed on a global basis (Rasmusson, 2016; Thorpe, et al., 2015; Yuen, et al., 2016). Research is still reaching a consensus on the availability of newer technologies, such as high-speed broadband, with studies pointing out discrepancies in access between Caucasian, Hispanic, and African American students (Honig, 2013) and studies pointing to near parity in access for students across demographics (Smith, 2014). The literature is clearer on overall usage, and demonstrates that minority students spend more time online than their peers, taking part in social networking and friendship-driven activities (Warschauer, 2016). African American students are, according to a Pew Research poll, significantly more prolific users of Twitter (Smith, 2014). However, usage alone does not indicate meaningful engagement. Minority students are less likely than their peers to engage in creative or generative behavior while online, and less likely to use

more advanced functions such as word processing and managing databases (DeBell & Chapman, 2006; Gormley & McDermott, 2014).

Technology in the classroom has not always necessarily meant the same thing or offered the same benefits to all classes. Schools with large minority populations typically have higher student to computer ratios than other institutions (Gray, Thomas, & Lewis, 2008; National Center for Education Statistics, 2006). Research has shown that time spent actively engaging with a computer or the internet is a predictor for scholastic success, and that there are differences in terms of gender and ethnicity regarding students' trends in use (Jackson, et al., 2008). By the age of twelve, a male African American student is less likely than his peers to be an active and engaged user, and this will affect his academic performance in the modern classroom. A recent study of primary school-aged Hispanic students in south Texas found that while the majority had physical access to the relevant technology, it was underutilized (Bussert-Web & Henry, 2016), with most students in the study demonstrating below average digital literacy skills and reporting a minimum of actual computer use in the classroom.

On the other hand, a study of southern California schools found that high resource schools were better positioned to take advantage of technology in the classroom than low resource schools (Valadez & Duran, 2007). Access to greater resources on the school level not only means greater physical exposure to computers but it also translates to advantages in communication and more opportunity to engage meaningfully with the curriculum. When young girls, students with free or reduced lunch, or African American or Hispanic students can use computers in school they take full advantage (Becker, 2006).

The purpose of the current study was to evaluate the usage and effectiveness of a CAI (Waterford Early Reading) program for African American, Caucasian, and Hispanic students when access is available in the classroom. It is predicted that kindergarten and first grade students using the program will show improved literacy skills.

Methods

Participants

This study consisted of kindergarten and first grade students (N = 1,577) enrolled in a public school district in South Carolina during the 2016-2017 school year.

For kindergarten, the experimental group (n = 699) consisted of students that used the Waterford Early Reading Program for more than 2,000 minutes during the 2016-2017 school year. The control group (n = 40) consisted of students that used the Waterford Early Reading Program for less than 500 minutes during the 2016-2017 school year.

For first grade, the experimental group (n = 777) consisted of students that used the Waterford Early Reading Program for more than 2,000 minutes during the 2016-2017 school year. The control group (n = 61) consisted of students that used the Waterford Early Reading Program for less than 500 minutes during the 2016-2017 school year.

Materials

The Waterford Early Reading Program (ERP)

The program offers a comprehensive, computer-adaptive pre-reading and reading curriculum for pre-kindergarten through second grade students. The software presents a wide range of multimedia-based activities in an adaptive sequence tailored to each student's initial placement and his or her individual rate of growth throughout the complete reading curriculum.

Developmental Reading Assessment (DRA)

The DRA is a standardized reading test used to determine a student's instructional level in reading. The DRA is administered individually to students by teachers and/or literacy coaches.

Procedure

Kindergarten students were expected to use ERP for fifteen minutes per day, five days per week, and first grade students were expected to use ERP for thirty minutes per day, five days per week. Usage was tracked within the program and monitored weekly by Waterford personnel, and total minutes of usage of ERP for the school year per group was calculated. The DRA was administered at the middle and at the end of the school year.

Results

Kindergarten

Total Usage by Ethnicity

An ANOVA was conducted to examine the effects of demographics on total usage for all students with usage in kindergarten. There was a significant effect of ethnicity on total usage for students in kindergarten, $F(8, 2843) = 14.10$, $p < .01$. Post hoc analysis using Tukey HSD showed that African American students had significantly more usage than Hispanic students.

Group Differences Using an Independent Samples t-test

An independent samples *t*-test examining group differences in DRA gains from middle of year scores to end of year scores between the experimental group and the control group was conducted (Tab. 1). Analysis of gains revealed a significant difference between groups, $t(1, 737) = -3.34$, $p < .01$, due to higher gains made by experimental students ($M = 2.41$) than by control students ($M = 1.73$). Effect size ($d = 0.54$).

Group Differences by Demographics Using Two-Way ANOVAs

Two separate two-way ANOVAs were conducted to examine the effects of Waterford curriculum and demographics on DRA gains (Tab. 1).

There was no significant interaction between the effects of gender and Waterford curriculum on DRA gains, $F(1, 735) = 0.14$, $p = .706$. Simple effects analysis showed that for males and females, students in the experimental group significantly outperformed students in the control group.

There was a significant interaction between the effects of ethnicity and Waterford curriculum on DRA gains, $F(4, 726) = 2.50$, $p < .05$. Simple effects analysis showed that African American students in the experimental group significantly outperformed students in the control group. Hispanic students in the experimental group scored slightly higher than students in the control group, but the difference was not significant.

Group Differences Using an ANCOVA

An ANCOVA examining group differences in DRA end of year scores while covarying for DRA middle of year scores was conducted (Tab. 1). Analysis of DRA end of year scores, covarying for DRA middle of year scores, revealed a significant difference between groups, $F(1, 736) = 6.33$, $p < .05$, due to higher end of year scores made by experimental students ($M = 4.84$) than by control students ($M = 4.32$). Effect size ($d = 0.25$).

Group Differences by Demographics Using ANCOVAs

Two separate two-way ANCOVAs were conducted to examine the effects of Waterford curriculum and demographics on DRA end of year scores, covarying for DRA middle of year scores (Tab. 1).

There was no significant interaction between the effects of gender and Waterford curriculum on DRA end of year scores, covarying for DRA middle of year scores, $F(1, 734) = 0.23$, $p = .629$. Simple effects analysis showed that

for males and females, students' end of year scores in the experimental group were slightly higher than in the control group, but the difference was not significant.

There was no significant interaction between the effects of ethnicity and Waterford curriculum on DRA end of year scores, covarying for DRA middle of year scores, $F(4, 725) = 1.79$, $p = .129$. Simple effects analysis showed that for African American students, students in the experimental group significantly outperformed students in the control group. Hispanic students in the experimental group had end of year scores slightly higher than students in the control group, but the difference was not significant.

	Gains					ANCOVA				
	Experimental		Control			Experimental		Control		
	M	*SD*	*M*	*SD*	*p*	*M*	*SD*	*M*	*SD*	*p*
Kindergarten Overall	2.41	1.25	1.73	1.38	.00**	4.84	2.01	4.32	2.00	.01*
Gender										
Male	2.37	1.24	1.75	1.51	.01*	4.82	2.04	4.37	2.16	.07
Female	2.46	1.27	1.67	1.07	.03*	4.86	1.97	4.21	1.62	.07
Ethnicity										
African American	2.40	1.20	1.20	1.32	.00**	4.82	2.11	3.86	1.60	.01**
Hispanic	2.04	1.31	2.00	0.85	.93	4.55	2.32	4.52	0.99	.94

*$p < .05$, **$p < .01$

Table 1: Kindergarten DRA gains and end of year scores covarying for middle of year scores

First Grade

Total Usage by Ethnicity

An ANOVA was conducted to examine the effects of demographics on total usage for all students with usage in first grade. There was a significant effect for ethnicity on total usage for students in first grade, $F(7, 3694) = 8.36$, $p < .01$. Post hoc analysis using Tukey HSD showed that Caucasian students had significantly more usage than African American students.

Group Differences Using an Independent Samples t-test

An independent samples *t*-test examining group differences in DRA gains from middle of year scores to end of year scores between the experimental group and the control group was conducted (Tab. 2). Analysis of gains revealed a significant difference between groups, $t(1, 66) = -3.21$, $p < .01$, due to higher gains made by experimental students ($M = 3.53$) than by control students ($M = 2.84$). Effect size ($d = 0.43$).

Group Differences by Demographics Using Two-Way ANOVAs

Two separate two-way ANOVAs were conducted to examine the effects of Waterford curriculum and demographics on DRA gains (Tab. 2).

There was no significant interaction between the effects of gender and Waterford curriculum on DRA gains, $F(1, 834) = 0.24$, $p = .628$. Simple effects analysis showed that for males and females, students in the experimental group significantly outperformed students in the control group.

There was no significant interaction between the effects of ethnicity and Waterford curriculum on DRA gains, $F(5, 825) = 1.77$, $p = .117$. Simple effects analysis showed that for African American and Caucasian students, students in the experimental group significantly outperformed students in the control group.

Group Differences Using an ANCOVA

An ANCOVA examining group differences in DRA end of year scores while covarying for DRA middle of year scores was conducted (Tab. 2). Analysis of DRA end of year scores, while covarying for DRA middle of year

scores, revealed a significant difference between groups, $F(1, 835) = 41.80$, $p < .01$, due to higher end of year scores made by experimental students ($M = 11.15$) than by control students ($M = 10.02$). Effect size ($d = 0.51$).

Group Differences by Demographics Using ANCOVAs

Two separate two-way ANCOVAs were conducted to examine the effects of Waterford curriculum and demographics on DRA end of year scores, covarying for DRA middle of year scores (Tab. 2).

There was no significant interaction between the effects of gender and Waterford curriculum on DRA end of year scores, covarying for DRA middle of year scores, $F(1, 833) = 0.27$, $p = .606$. Simple effects analysis showed that for males and females, students in the experimental group significantly outperformed students in the control group.

There was no significant interaction between the effects of ethnicity and Waterford curriculum on DRA end of year scores, covarying for DRA middle of year scores, $F(5, 824) = 2.00$, $p = .076$. Simple effects analysis showed that for African American and Caucasian students, students in the experimental group significantly outperformed students in the control group.

	Gains					ANCOVA				
	Experimental		Control			Experimental		Control		
	M	*SD*	*M*	*SD*	*p*	*M*	*SD*	*M*	*SD*	*p*
First Grade Overall	3.53	1.33	2.84	1.63	.00**	11.15	1.96	10.02	3.65	.00**
Gender										
Male	3.59	1.37	2.82	1.72	.00**	11.15	2.08	9.95	3.68	.00**
Female	3.46	1.29	2.86	1.56	.03*	11.14	1.81	10.11	3.65	.00**
Ethnicity										
African American	3.44	1.45	2.60	1.98	.01**	11.04	2.21	9.47	4.18	.00**
Caucasian	3.56	1.30	2.44	1.42	.00**	11.19	1.91	9.89	3.59	.00**

*$p < .05$, **$p < .01$

Table 2: First grade DRA gains and end of year scores covarying for middle of year scores

Discussion

According to the U.S. Department of Education, technology and education have become paired together in discussions of improving educational impacts, while a decade ago the efficacy of technology in the classroom was still being questioned (U.S. Department of Education, 2017). Technology, when used with fidelity, personalizes education and engages the student; not using technology when it is available deprives students of higher learning potential. Incorporating technology into the classroom and transitioning into the digital age are encouraged to increase efficiency of learning, and further research is now needed to improve technology so that all students are successful in school.

In this study of technology in the classroom, significant, positive results were found in both kindergarten and first grade. Consistent with prior research (Gormley & McDermott, 2014), significant differences in usage were found between ethnicities despite equal access in the school district. Despite significant differences in overall usage between ethnicities, improvements in literacy skills were observed in all students. Waterford curriculum meaningfully engages students as active participants in their own education.

Students that had high usage of Waterford outperformed their control counterparts. Additionally, across demographics, experimental students had higher gains and higher end of year scores, covarying for middle of year scores, than control students. Overall, this demonstrates that high usage of Waterford curriculum positively impacts students' scores and, consequently, early literacy skills. These results support the notion that using technology is beneficial for young learners, specifically for increasing efficiency of students learning how to read. Additionally, this study provides evidence in support of high-quality, personalized technology assisting all students equally and positively.

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