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Research Article

Student Gender and Achievement within a Technology-Enhanced Learning Environment

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ABSTRACT

Gender differences in social studies and science achievement, in a Technology-Enhanced Learning Environment were examined from a group of 474 (males=237 and females=237) first-time 8th grade test takers from one primary school district. Unequal variance independent samples t-tests were used to test the magnitude of gender differences. Female students received significantly greater social studies achievement than males, but there were not significant differences in science achievement scores. Achievement assessments for students with assigned laptops showed significant gender differences in social studies, but not in science.

Keywords: Digital use divide; Educational technology; Gender differences; Multimedia learning; Technology; Technology-enhanced learning, Technology-enhanced instruction

INTRODUCTION

Major changes in the education-related law (i.e., Every Student Succeed Act) set a national vision and plan to enhance K-12 learning, prepare students for college, careers, and the digital-based economy in which they will make their living (U.S. Department of Education) [1]. Technology-enhanced learning environments are ubiquitous in schools today. A Technology-Enhanced Learning Environment (TELE) described a learning environment in which students used digital tools (i.e., laptop etc.) to support and facilitate learning. TELE is important for many reasons. It is the standard of education, within K-12 schools, which is expected today (USA Department of Education), and technology-enhanced learning can also improve achievement (USA Department of Education). Yet, achievement outcomes remain unchanged. In recent years, the gap in achievement between males and females in TELE has received increased attention the United States (USA Department of Education). Particularly, eighth grade females, on average, are receiving higher grades than males in social studies and science [2]. Vigilant discussions suggest individual and contextual factors may contribute to these differences in achievement. In general, variables like subject area and gender differences in student perceptions and attitudes about the use of digital tools for learning are suggested to have a significant influence on academic achievement [3,4]. This study is particularly interested in the identification of gender differences in social studies and science achievement across an eighth grade TELE. The current study was conducted in the Southeast United States, where every student was assigned a laptop to support and facilitate learning in a unified middle school district with one single state curriculum and assessments. Educational provisions are seen in the context of a coherent and continuous K-12 school year. Middle school includes sixth to eighth grade.

LITERATURE REVIEW

Prior studies of student achievement differences focused on environmental factors (i.e., traditional learning environment *versus* technology-enhanced learning environment) and achievement. Most studies failed to examine personal factors such as student gender on achievement within TELE, or they failed to provide empirical data on gender differences in achievement within TELE [5,6]. Consequently, the USA Department of Education and others were eager for empirical data on the differences in achievement outcomes between males and females within a TELE [7]. This raised the question about to what extent, if any, are there gender differences, in social studies and in science achievement, for students assigned a laptop to support and facilitate learning [7-10]. The current study was based solely on student gender, and therefore, the results provided a fairly good picture of student gender and achievement in a TELE. Specifically, the research questions were the following: Research Question 1: To what extent, if any, is there a statistically significant difference in social studies achievement between males and females? Research Question 2: To what extent, if any, is there a statistically significant difference in science achievement between males and females?

The answers to these questions have practical significance because

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they provided important evidence about student achievement and learning experiences in social studies and science. According to the National Assessment of Educational Progress (NAEP), surveys and questionnaires give results context, but data informs education policy and practice by reporting the achievement of various student groups beyond the Nation's Report Cards. This study offers data into gender differences in social studies and science achievement to spark:

(1) Policy change: Educators may use the data as evidence as to address the growing need to reduce the difference in scores in the subject areas; and

(2) Innovative practices: Educators can use this information as they develop important strategies, curriculum, instruction, and opportunities for technology use in science and social studies classrooms.

METHODOLOGY

Participants

This study employed a quantitative methodology with an ex post facto design [8]. Grand Canyon University Institutional Review Board determined this study to be exempt from IRB review according to federal regulations (reference#IRB-2022-4372). At the time of the study, the school district's overall enrollment was 37,769 with 8,254 students attending grades 6-8. The district's student population included both males and females. The district's aim was to support student achievement including ensuring a positive learning environment for effective lesson delivery and providing appropriate resources [11-20]. To support student achievement, every student was assigned a laptop to facilitate learning. The total number of students at the selected school at the time of the study was 1,465. The gender breakdown at this school was 51% male and 49% female. A total sample size of 128 (males=64 and females=64) student scores, the sample size, to answer each research question, was 474 (males=237 and females=237). Each student had both social studies and science ACH scores, while being a first-time 8th grade test taker. From sixth to eighth grade, students had the same teacher, at each grade level, in most subjects (e.g., all eighth-grade students had the same social studies and science teacher) [21].

Measures

This study is based on de-identified archival data from the 2020-2021 state ACH assessments. Student gender demographics were used to complete this study. Student achievement was assessed at the end of each grade level by a state ACH assessment in four subject areas. State ACH assessments are a series of standardized achievement-based exams designed to evaluate K-12 learning ndards, concepts, and mastery in four subject areas (language arts, mathematics, social studies, and science). All versions of the state ACH assessments yield criterion-referenced achievement (ACH) scores. Data were collected from the State ACH assessment [22-25].

Data

Student achievement: Social studies and science achievement was measured using de-identified ACH scores because they classify and describe student mastery on the assessments. Specifically, an ACH score was reported for each of the content objectives measured by the social studies and science version of the state ACH assessment [27-30]. The ACH score reflects what a student knows and can do (i.e., mastery) in social studies including geographic perspective, historical and cultural perspective, civics and government perspective, and economic perspective. In science, the ACH score reflects what a student knows and can do (i.e., mastery) in science inquiry, physical science, life science, earth and space science, science and technology, and personal and social perspective in science [31-40].

Social studies and science ACH scores are derived from a combination of 51-55 selected-response items (i.e., multiple choice questions) and constructed- response items (i.e., essay questions). The response items require higher-order thinking skills which provide a strong proxy of achievement because students must apply, synthesize, and evaluate information rather than memorize facts [41-45]. However, grade distribution reports for each subject area were expressed in terms of a student achievement (ACH) score, which help stakeholders identify students' mastery. The ACH score is continuous level data that describes student mastery, in social studies and science, on a continuum that ranges in value from 1 to 4 (e.g., 1=below; 2=approaching; 3=on-track; and 4=mastered. The difference between individual ACH scores from each group was used to evaluate any difference between variables in this study. The ACH scores, derived from state ACH assessments, were well-suited to assess achievement for this study because state assessments are known as reliable and valid instruments to measure achievement on subject material as well as for their high standards in research; item validity including principal component analysis (39.58 and 49.46) and correlation analysis (0.55 to 1.00 and 0.45 to 1.00); item reliability including coefficient alpha (0.80 and 0.81); and technical quality [9].

Student gender: Student gender was measured using de-identified archived student gender demographic data. Student gender was collected within a tabbed Excel sheet, from the school district, that contained student's ACH scores. Specifically, 'male' or 'female' was listed next to each student's corresponding ACH score. Because the aim of this study was to examine the difference in achievement between males and females within a Technology-Enhanced Learning Environment (TELE), this demographic information was necessary to address the research problem. Social studies and science achievement was assessed on an interval scale and collected using de-identified archived ACH scores in social studies and science [46-55]. Student gender was assessed on a dichotomous scale and collected using archived student gender demographics data.

Although the primary use of student gender demographics was to examine any potential difference in achievement, this secondary data was also used for descriptive statistics, to summarize de-identified archived data, and summarize variables including the mean, sample variance, sample standard deviation, and confidence interval. This facilitated the description and illustration of the data to discuss patterns and interpret the data [56-65].

Data analysis approach

Data analysis procedures involved a primary (i.e., independent samples t-test) or alternate statistical analysis of data. The quantitative data analysis approach for this study was an independent-samples t-test and the standard 0.05 level of statistical significance to determine whether the difference in achievement between males and females was statistically significant [66-75]. Various statistical analyses (See Appendix A) such as Assumptions test, Q-Q plots, histograms, skewness, and kurtosis, power analysis, post hoc G* Power analysis, etc., proved the reliability and validity of the data.

RESULTS

Descriptive

The total number of scores for science achievement was 474. This included 237 scores in the male group and 237 scores in the female group. Per TDOE, the ACH 144 score is continuous level data that describes student mastery, in social studies and science, on a continuum that ranges in value from 1 to 4 (e.g., 1=below; 2=approaching; 3=on-track; and 4=mastered. The score range is 1-4. The highest score a student can get is four. For science ACH, the male group had a mean ACH score of 2.42, and a standard deviation of 0.848, and the female group had a mean ACH score of 2.56, and a standard deviation of 0.760. Table 1 presents the statistics on the dependent variables [76-85].

Research question 1: The first research question dealt with student gender difference in social studies achievement. An unequal variance independent samples t-test was used to examine whether there was a statistically significant difference in social studies achievement score for males and females enrolled in a TELE because the assumption of equality of variances was violated (p=0.004), as assessed by Levene's test for equality of variances [86]. The null hypothesis stated that there was no statistically significant difference in achievement, in social studies, as measured by state achievement assessment between males and females in a TELE. The null hypothesis was rejected. The mean social studies ACH score was higher for female students (M=2.54, SD=0.836) than male students (M=2.35, SD=0.953), showing a statistically significant difference, M=2.54, 95% CI [-0.343 to 0.020], t(464.159)=-2.204, p=0.028, d=0.90 This result indicated that the differences between the two groups' means was statistically significant, and that there was 95% confidence that the true mean difference lies somewhere between -0.343 and -0.020 (Laerd, 2015). Thus, it is most probable that there was a significant effect. Table 2 presents the results for unequal variance independent samples t-test of Social Studies Achievement (SSA).

Research question 2: The second research question dealt with student gender difference in science achievement. An unequal variance independent samples t-test was used again because the assumption of equality of variances was violated (p=0.046), as assessed by Levene's test for equality of variances [87-95]. The null hypothesis stated that there was no statistically significant difference in achievement, in science, as measured by state achievement assessment between males and females in a TELE. This study failed to reject the null hypothesis. The mean science ACH score for female students (M=2.56, SD=0.760) and male students (M=2.42, SD=0.848), were not significantly different, M=2.56, 95% CI [-0.285 to 0.006], t (466.435)=-1.882, p=0.060, d=0.81. This result means that there was not a statistically significant difference between the means, and that there was 95% confidence that the true mean difference lies somewhere between -0.285 and 0.006 [96-99]. Given the sample size, post hoc analysis showed 99% power to observe a large effect of d=0.81 (See Appendix D). Thus, it is most probable that there was no significant effect. Table 3 presents a summary of these results [100-105].

Table 1: Descriptive statistics for dependent variables (social studies and science achievement) by independent variable group (male and female).

Gender		N	Mean	Std. deviation	Std. error mean
SSA	Male	237	2.35	0.953	0.062
	Female	237	2.54	0.836	0.054
SCA	Male	237	2.42	0.848	0.055
	Female	237	2.56	0.76	0.049

Table 2: Research question 1: social studies ach unequal variance t-test results.

		t	df	Significance	Mean Difference	Std. Error Difference	95% confidence interval of the difference	
				Two-Sided *p*			Lower	Upper
SSA	Equal variances assumed	-2.204	472	0.028	-0.181	0.082	-0.343	-0.02
	Equal variances not assumed	-2.204	464.159	0.028	-0.181	0.082	-0.343	-0.02

Table 3: Research question 2: Science ach unequal variance t-test results.

		t	df	Significance	Mean difference	Std. error difference	95% confidence interval of the difference	
				Two-sided *p*			Lower	Upper
SCA	Equal variances assumed	-1.882	472	0.06	-0.139	0.074	-0.285	0.006
	Equal variances not assumed	-1.882	466.435	0.06	-0.139	0.074	-0.285	0.006

DISCUSSION

The results of this current study were mixed in terms of alignment with prior studies on gender and achievement outcomes. As discussed earlier, previous authors claimed that differences in student motivation and perceptions about the use of digital tools for learning between gender groups may influence achievement outcomes within TELE [3,4]. This current study provided empirical data that showed a significant difference in social studies achievement between gender groups in a TELE; however, due to the fact that no information was presented in the study regarding how students used the laptops in their instructional activities and test preparation, no parallels can be drawn other than to say that the students in this study had access to their own laptops [106-115].

Additionally, this current study did not align with the results of previous studies regarding curriculum effects and achievement outcomes. For example, previous studies claimed that curriculum enriched with technological applications may lessen the effects of individual differences that impact science achievement, particularly for students with assigned digital tools to support and facilitate learning [116]. The students in this current study participated in an innovative science curriculum. The findings in this current study did not show a significant difference science achievement between gender groups. Therefore, the results of this study did not align with those above. However, these statements must be interpreted with caution since no information was provided in this current study about how technology was used in science curriculum. Future research should examine curriculum effects between gender groups in a TELE, particularly since the students in the school studied had access to their own laptops and were taking part in an innovative science program [117].

Most prior studies failed to provide data regarding differences in achievement between gender groups within a Technology-Enhanced Learning Environment [3,4]. This current study advanced the research on student gender and achievement because it provided empirical data on differences in social studies and science achievement between gender groups in a school where students had their own laptops. Suana found significant differences between male and female motivation and perceptions of technology-enhanced learning in physics [4]. Specifically, females showed higher positive behavior (i.e., high autonomous motivation and engagement) to learn physics within the TELE, while males showed higher negative behavior (i.e., low autonomous motivation and engagement) to learn physics within the TELE. As such, high and low autonomous motivation and perceptions of technology-enhanced learning creates student gender effects, which may impact achievement outcomes. While the results of this current study cannot be attributed to curriculum or technology, Sauna did find gender differences in motivation to learn science. The results of this current study did not find any significant differences between genders in science. Due to conflicting findings, more research is needed [4]. Yilidrum researched the impact of science teaching enriched with technological applications on the achievement of seventh grade students. Results showed students who were exposed to the intervention found that the technology enriched science teaching strategies had significantly higher scores than students who did not receive this intervention [118-122]. The authors noted that technology enriched teaching should be used in science to meet the needs of individual students. The results of this current study did not show that students who had access to one-to-one laptop use had differences in science achievement, so the results do not align with those of Yilidrum et al. More research is recommended [123].

Limitations

The limitations of a study are those characteristics of design or methodology that the researcher could not control and may impact or influence the interpretation of the findings. Within every study, limitations exist. Although efforts were made to minimize any limitations, this study had limitations which could not be controlled. One limitation of this study was sampling strategy. Students were not randomly assigned to social studies and science groups. Since this study was ex post facto, this is considered a built-in design weakness. Ex-post facto research presents the problem of researchers being denied the capability of randomization. Students or parents did not have the option of applying for membership in the learning environment because student sorting into social studies and science classes had already occurred prior to conducting this study. Since the researcher was not able to randomize the grouping, it is difficult to determine a cause-effect relationship.

The researcher had no control over variables; therefore, the relationship cannot be asserted with the same confidence as one conducting experimental research. This is a limitation of the ex post facto design. The second limitation of this study was resources for data collection. The data were not analyzed based on SES or race; therefore, the differences that were determined are only a snapshot in terms of other factors. The students attended a Title I school; however, SES and race data were not available for analysis. As a result, the findings could be subject to other interpretations. Therefore, it is recommended that another study look at differences in achievement between race groups (e.g., Black males and Black females) in a TELE.

The final limitation of this study was assessment areas. The specific categories measured within social studies and science assessments (e.g., geographic perspective, historical and cultural perspective, science inquiry, physical science, life science, etc.) were limited because the curricula were established prior to conducting this study. This limitation was unavoidable because the researcher had no control over the curricula. As such, there might be other topics that could fit in the broad definitions. Since this district had particular assessment blueprints, these results may not be generalizable to all schools in the USA.

CONCLUSION

A goal for most schools is to increase student achievement. However, schools that have students with assigned laptops for learning may need to mitigate disparities in achievement between gender groups. Decreasing student gender disparities in achievement for students with digital tools can be a difficult task. Educator's use of technology to support student-centered practice is rare even among technology enriched schools (USA Department of Education). Delivering a curriculum enriched with technological applications may mitigate such disparities in achievement. The intent of the researcher was to add to the literature available to educators seeking empirical data regarding gender disparities in achievement, particularly for students in social studies and science who had assigned laptops to support and facilitate learning. Findings showed there was a statistically significant difference ($p=0.028$) in ACH scores, in social studies, between males and females in a TELE. Females had higher social studies ACH scores ($M=2.54$, $SD=0.836$) than males ($M=2.35$, $SD=0.953$). However, results showed there was not a statistically significant difference ($p=0.060$) in science ACH scores between males (M=2.42, SD=0.848) and females (M=2.56, SD=0.760) in a TELE. The results of this study may be used by school leaders and teachers as they create strategies, curriculum, lesson plans, and integrate technology as the students all have their own laptop in the district where data collection occurred. The findings of this study provided educators with data that there is a need to pay more attention to disparities in achievement between gender groups, particularly social studies. This is beneficial information for educators to assess strategies and consider their options to mitigate disparities in achievement between gender groups, especially in social studies. The findings of this study may apply to school districts that contain a large economically disadvantaged student population. The school district in this study implemented a one-on-on laptop program. The findings of this study offer information for schools that have similar populations and are assessing strategies and considering their options to mitigate disparities in achievement between gender groups.

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