RESEARCH PAPER

COMPUTER USE IN DIVERSE LEARNING CONTEXTS IN ELS 2002: GENDER, RACE AND LEARNER-CENTEREDNESS EFFECTS AND IMPLICATIONS

By

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ABSTRACT

This paper examines the relation between computer use in diverse learning contexts and math achievement, and the gender and ethnicity-based differences in that relation. The study selected learner centeredness as a meaningful pedagogy in using computers because of its importance in technology-based learning. Along with the emerging notion of the importance of learner control in learning environments, technology has been expected to enable learner-centered learning environments. Moreover, learning models (including learner-centeredness) suggest an important framework for successful integration of technology into teaching and learning. The study employs multiple regression models to 15,430 10th grade students from the Education Longitudinal Study 2002 (ELS: 2002), a US nationally representative database. The results confirm the significant effects of computer use in diverse contexts on student academic performance and its differential effects for gender and race. In particular, computer use for school work was a significant predictor of math achievement for 10th graders, especially for Caucasian students. The effects of female students' computer use for their own learning in math were lower than those for males; these effects were pronounced in the Hispanic and Asian groups. The study results have implications for the theory and practice of computer use.

Keywords: Gender, race, computer use, math achievement, learner-centeredness.

INTRODUCTION

Computer use which is pedagogically sound is of critical importance because much of students' identity and thinking is shaped by computer use (Nachmias, Mioduser, & Shemla, 2001). Moreover, the current statistics on the computer use add significance to evaluate the proper use of computers as educational tools. Current Population Survey 2003 in USA estimates that approximately 53 million students from preschool to high school use computers - 91 percent of all students, and about 35 million students in USA use the internet - 59 percent of all students (DeBell & Chapman, 2006).

Along with the dramatic growth of computer use, the frequent use of computers outside formal education has been a concern among educational researchers and practitioners. The NCES (National Center for Education Statistics) report (2006) states that 45 percent of students in USA use internet at home and 43 percent of students use internet in school. In response to the frequent use of computers outside schools, Barron, Martin, and Roberts [2007] emphasize computer use to link informal and formal learning from the perspective of learning ecology framework. Similarly, the present research examines the effects of computer use in diverse contexts seeking to link within and outside-school learning. This study also explores computer use in diverse contexts from a pedagogical perspective by introducing the concept of learner centeredness to cover computer use in various settings. For this purpose, this study uses the Educational Longitudinal Study (ELS) of 2002 to explore the differential effects of computer use. Two major variables have been chosen to examine student learner-centeredness in the use of computers: computer use for schoolwork and computer use for individual learning at various settings including home, school and other places. The study further explores the gender and ethnicity-based differences in the relation between these computer users and math achievement. The following research questions guided the study:

What is the relation between student math achievement and the frequency of computer use for school work in various contexts? How does it vary with regard to gender and ethnicity after controlling for SES?

What is the relation between student math achievement and the degree of computer use for their own learning regardless of sites? How does it vary across gender and ethnicity after controlling for SES?

Literature review

Computer use across various contexts

In a recent study, Erstad (2006) mentioned that most computer competency is acquired by students outside formal institutions, and that this tendency is international. However, the review of the recent literature indicates that only a small amount of research has been done in this area. Moreover, the results of those studies on the impact of computer use in non-school settings have been inconclusive. Fuchs and Wössmann (2004) have reported that when students used computers for education at home, they demonstrated improved academic achievement. Wenglinsky (2006) has also shown that the amount of time devoted to schoolwork using a computer outside the school had a positive effect on student achievement.

On the other hand, Bebell, O'Dwyer, Russell, and Seeley [2004] warned a negative impact of computer use outside the school on student academic performance, especially at home. Negative outcomes of computer use outside schools are generally attributed to computer-use for entertainment. Fuchs and Wossmann's study (2004) showed that many students spent a great deal of time playing online games or chatting, thus spending less time on learning at home.

Learner centeredness

This study selected learner-centeredness as a meaningful pedagogy in using computers and internet because of its importance in technology-based learning. Along with the emerging notion of the importance of learner control in learning environments (Gerhard, 2001), technology has been expected to enable learner-centered learning environments (Warschauer, 2000). Moreover, learning models (including learner-centeredness) suggest an important framework for successful integration of technology into teaching and learning (Cummins & Sayers, 1995). However, despite the importance of learner-centeredness, caution needs to be taken, as learner-centeredness might not be effective for everyone. In a learner-centered learning environment, learners are responsible for their own material searching, as well as constructing and representing their own learning (Hannafin & Land, 1997). Because of increased learners' responsibility for their own learning, while independent and autonomous learners may benefit from learner-centeredness, those who prefer cooperation and interdependence may not do well in this environment. In addition, some learners feel lost and frustrated when they were exposed to an open learning environment that involved a huge amount of information (Hill, Wiley, Nelson, & Han, 2003) and some learners had trouble understanding not only learning materials but also making a decision for the learning strategies. It requires discretion to determine how much learner control should be given to the learners in order to have an effective learner-centered learning environment.

In view of the differential effects of learner-centeredness, this study attempts to explore two levels of learner-centeredness in learning: learner control partially given with some guidance and full learner control given without guidance. Computer use for schoolwork implies some amount of guidance by teachers, the experts in content and instruction. The variable of computer use for school work in the ELS database was measured by the frequency of computer use for school work in various contexts. Thus, this variable was used as a proxy to represent student's computer use with partial learner-centeredness in various contexts. The variable of computer use to learn on one's own was used as a proxy to measure learner-centeredness in computer use because it can indicate the high degree of learner control in a student's own learning in various contexts.

This study also paid special attention to learner-specific process, as Hill, Wiley, Nelson, and Han (2003) suggested. Considering the importance of learner centeredness as pedagogy in the use of computers and internet, it would be important to examine its potential differential effect among different groups. In this regard, the study focused on the characteristics of learners who may benefit from learner-centeredness by investigating differential effects among different races and genders.

Gender and ethnicity-based difference of computer use

Researchers have identified gender difference as an important issue in computer-related research (Gunawardena & McIsaac, 2003). Despite the perceived importance of gender issues in computer use, there is a gap in the studies related to gender differences and computer use (Romiszowski & Maso, 2003). The deficiency in the research is partly due to the perception that there is no gender difference in computer use. In support of this notion, no significant gender difference in the rate of using and accessing computers was reported by the Current Population Survey (CPS) (DeBell & Chapman, 2006). Also, Ory, Bullock and Burnaska (1997) found no gender difference in the use of, and attitude toward computers.

Some other studies, on the contrary, reported that males demonstrated better performance, higher confidence, and more access in computer use than female counterparts. Volman, and Van Eck, (2001) reported that male students had more computer-related skills and knowledge than their female peers. Males seemed to have more confidence in using new computer-based technology than females (Koohang, 2004). These findings seemed true internationally: Weaver (2000) reported that males are found to have more experience and more access to computers internationally. Barron, Martin and Roberts (2007) showed that males were over-represented in computer-related fields in most countries.

Beyond the difference in accessing and using computers, the difference in preferred learning activities has been reported. Based on various research results, Heesmker, Brink, Volman and ten Dam (2005) showed that females favored collaboration and computer features which enable interaction with others and provide more flexibility for learning. Researchers in this regard exhort that instructions in computer use should be designed to accommodate the preference of female as well as male (Kerr, 2003). The study examines the impact of computer use for gender across various contexts and presents gender-difference based suggestions.

Along with gender differences in computer use, a difference among various races has been reported. A survey study reported that Caucasians had more access to computers and the internet than other minority groups, while there was no difference between Asians and Caucasians (DeBell & Chapman, 2006; Messineo & DeOllos, 2005). In addition to the accessing difference among the different races, other differences were reported. While minority students tended to use computers for lower- level tasks, Caucasian students used them for higher- level tasks (Heemskerk, Brink, Volman, & ten Dam, 2005). Caucasian students were more likely to use computers and the internet more effectively for their own learning compared with their minority peers (Gorski, 2003). In terms of e-mail related skills, significantly more Caucasian students evaluated themselves highly than minority students (Messineo & DeOllos, 2005).

In addition to the difference in physical access, the perception and use of computers among various ethnic groups, and preferred pedagogy in computer use within their ethnic contexts have been reported. Compared with Non-Asian students, Asian-American students worked better cooperatively in groups than independently when using computers (Freedman & Liu, 1996). Chisholm (1995) suggested African- and Mexican-American students would prefer working together when using computers, as cooperation and interdependence are important in their culture. On the other hand, Caucasian students would like to work alone as independence and autonomy are important in their culture. Despite reported differences as cited, regrettably, there is scarcity of research on the impact of computers and the internet on academic achievement among various races. In this respect, this study empirically tested the potential differential effects of computer use on the performance of students from various ethnic groups.

Method

Data source and variables

This study used the Education Longitudinal Study of 2002 (ELS: 2002), a USA nationwide longitudinal dataset, from the National Center for Education Statistics (NCES). The ELS database was designed to provide assessment of the various cognitive and psychological aspects of high school students at two-year intervals. The current database is composed of the measures of 10th and 12th graders: the second follow-up database aims to include data on the students' transitions into post-secondary education or employment. The data collection method was a two-stage probability sample design in which the primary sampling units were schools and the second-stage units were students within schools. Out of approximately 27,000 public and private schools in USA, 1,221 schools were selected according to probability proportional to size. Among those schools, 752 schools were willing to join the survey. From each school of the 752 schools, 25 students were randomly selected.

In the spring of the base year 2002, data on more than 15,000 10th graders were collected from 752 high schools (N=15,430). In the spring of 2004, the first follow-up data were collected from seniors in nationwide high schools (N=16,252). For this study, we used base year data. This study applied a student weight (BYSTUWT) to represent the total population and used Primary Sampling Unit (PSU) and Strarum (STRAT_ID) to reflect and adjust design effects. By applying the weight and design effect variables, the study was also able to alleviate the problems caused by ELS-oversampled Asians and Hispanics and contained nonresponses.

Taking advantage of the large samples available on the ELS: 2002 database, the total database was split into five separate ethnic groups. The main purpose of the separate analyses was to examine the differential effects of computer use on students within each ethnic group (Caucasian, African-American, Hispanic, Asian and Native Indians). An additional benefit of the separate analyses was the straight forward interpretation because it did not depend on an indirect interpretation that compared results of each ethnic group with the reference ethnic groups.

To measure students' achievement, the math IRT score was used as a dependent variable for this study. The Item Response Theory (IRT) scale score was chosen among other available math scores (Math standardized score, Math quartile score and Math proficiency probability) because of its strength in assessing students' ability. For example, IRT scale scores separate each student's ability and test characteristics (e.g., Difficulty and discrimination). Thus, the IRT score is known to represent comparatively genuine student ability that is not contaminated by test characteristics.

Two computer variables, computer use for schoolwork and computer use to learn on one's own in school, at home, and other places, were the chief predictors of this study. These variables were chosen to represent computer uses in diverse learning contexts. The frequency of these two computer variables was measured by a 5-point scale (1 = Never; 2 = Rarely, 3 = Less than once a week; 4 = Once or twice a week; 5 = Everyday or almost every day). These two computer variables were centered before they were used to create the interaction terms with other variables in order to alleviate collinearity problems.

One of the specified objectives of this study was to examine the differential effects of computer use for the two gender groups. The gender variable was converted to a dummy variable with male as the reference gender (male = 0; female = 1). To test the interaction between computer use and gender, two interaction variables were created by using two centered computer variables and the gender dummy variable.

The socio-economic class of students (SES) was controlled in this study because it is an important contextual variable for student academic performance. The continuous SES variable was used for SES.

Analysis

The study's main statistical tool was multiple regression analyses using AM Statistical Software. The study analyzes the overall model for all students at first, and then separately tested the differential effects of computer use within each ethnic group by separating the data into five files for each race (Caucasian, Hispanic, Afro-American, Asian and Native Indians). The purpose of separate analyses for each ethnic group was to examine the effects within each ethnic group rather than comparing the effects among various race groups. For multiple regressions, the model at the 1st step was composed of two background variables: the SES variable and the gender variable. The two computer variables of our interests, computer use for schoolwork and computer use to learn on one's own, were added at the following step, controlling for two background variables. At the final step, the interaction variables between gender and two computer uses were added. Therefore, these three step regression analyses allowed the researchers to test the significance of the increased variance explained by the new set of variables, and to examine the effects of computer use and the interaction effects with background variables within each ethnic group.

Results

Descriptive statistics and correlation

Total number of students who participated in this study was 15,430 representing 3,429,549 students in USA. Among all students, Caucasians comprised the highest population (53.7%). Hispanic (13.7%) and African Students (12.5%) comprised the next highest population. Asian students were 9% and Native Indians were 0.8%.

The average of math IRT scores of 10th graders was 37.245, indicating that students, on average, had 37.245 right answers out of the total 72 math items (about 52%). The math score of males (mean=37.834) was slightly higher than that of female students (mean= 36.645). Among different races, the math score of Asians (mean=41.562) and Caucasian students (mean=40.522) were higher than those of Native Indians (mean=32.210), Hispanic (mean=31.108) and African-American students (mean=29.735).

The average SES composite score was -0.008, confirming that the SES average of all students in USA was close to the mean SES. The average frequency of computer use for schoolwork was 3.248, which indicates that students used computers for schoolwork or assignments, on average, approximately once a week at home, in school, and other places. The average frequency of computer use to learn on one's own was 3.050, meaning that students used computers to learn things on their own or to look for resources less than once a week. The correlation results revealed that all variables had a significant relationship with the math IRT scores. As we predicted, SES showed a significant relationship with the math IRT score ($r = 0.417$, $p < .01$). Both computer use variables also had significant relationships with math IRT scores; the correlation coefficient of computer use for schoolwork ($r = 0.239$, $p < .01$) was higher than that of learning on one's own ($r = 0.125$, $p < .01$).

Table 1 presents correlations, means, standard deviations, frequencies and percentages for the base year, weighted using AM Statistical Software Beta Version 0.06.03 (Cohen, 2005).

Regression models

In this section, the analyses results of an overall model following the separate analyses for each ethnic group are presented as shown in Table 2.

Overall model

The overall regression model for all students was statistically significant (Total $R^2 = 0.203$, $p < .01$). At the first analysis, SES was a significant predictor of the math achievement of 10th graders ($b = 6.988$, $p < .01$). Gender difference was also detected. The math achievement score of male students was significantly higher than the score for female students ($b = -0.952$, $p < .01$).

In the 2nd step, computer use for schoolwork ($b = 1.740$, $p < .01$) was significant. In other words, the frequent use of computers for schoolwork was associated with high math performance for the reference group (male students from the average SES families). Computer use to learn on one's own was not significant ($b = -0.025$, $p > .05$). In the 3rd step, although it did not notice the interaction effect of gender with schoolwork on performance, it found a significant gender effect in computer use to learn on one's own on performance. The effect of females'

Variable	1. Math IRT Score	2. SES	3. Gender	4. School Work	5. Learn on Own		Percentage	Frequency	Math IRT Mean
1. Math IRT Score	—					Ethnic group			
2. SES	0.417**	—				Caucasian	53.7	8735 (2067293)	40.522
3. Gender	-0.054**	-0.024*	—			African-American	12.5	2027 (492864)	29.735
4. School Work	0.239**	0.215**	0.135**	—		Hispanic	13.7	2227 (544305)	31.108
5. Learn on Own	0.125**	0.121**	-0.047**	0.468**	—	Asian	9.0	1349 (143121)	41.562
						Native Indian	0.8	131 (33127)	32.210
Mean	37.245	-0.008	1.496	3.248	3.050	Gender			
SD	11.946	0.723	0.500	1.155	1.332	Male	49.8	7689 (1729531)	37.834
N	15325 (3429548)	15325 (3429548)	15430 (3429549)	14311 (3207453)	14283 (3202662)	Female	50.2	7741 (1700018)	36.645

Note: ( ) indicate weighted cases
** p<0.05, ** p<0.01*

Table 1. Descriptive statistics and correlation

	Overall		Caucasian		African American		Hispanic		Asian		Native Indian	
	β	*(SE)*	β	*(SE)*	β	*(SE)*	β	*(SE)*	β	*(SE)*		*(SE)*
Step 1												
SES	6.988**	(0.172)	6.207**	(0.218)	3.912**	(0.419)	4.895**	(0.403)	5.133**	(0.565)	3.972**	(1.311)
Gender	-0.952**	(0.215)	-1.160**	(0.272)	-0.697	(0.446)	-0.986	(0.500)	-0.035	(0.883)	1.132	(1.804)
Step 2												
School work	1.740**	(0.130)	2.067**	(0.154)	0.935**	(0.258)	0.546*	(0.260)	1.953**	(0.494)	1.050	(0.666)
Learn on Own	-0.025	(0.102)	-0.138	(0.122)	0.165	(0.221)	0.743**	(0.259)	0.287	(0.328)	0.727	(0.763)
Step 3												
Sex*School work	-0.031	(0.213)	-0.414	(0.273)	0.379	(0.444)	0.267	(0.472)	-0.090	(0.907)	2.572*	(1.221)
Sex*Learn on Own	-0.731**	(0.192)	-0.345	(0.223)	-0.530	(0.415)	-1.076*	(0.477)	-1.465*	(0.717)	1.284	(1.382)
Step 1 R^2	0.181**		0.147**		0.070**		0.093**		0.121**		0.086*	
Step 2 R^2	0.201**		0.178**		0.083**		0.109**		0.155**		0.126*	
Total R^2	0.203**		0.179**		0.084**		0.113**		0.161**		0.179**	

** p<0.05, ** p<0.01*

Table 2. Regression Coefficients

computer use to learn on one's own on the performance, however, was significantly lower than that of males ($b = -0.731, p < .01$).

Caucasian model

The regression analyses for the Caucasian group also revealed statistically significant results (Total $R^2 = 0.179$, $p < .01$). Both SES and gender were significant predictors of math achievement ($b = 6.207$, $p < .01$; $b = -1.160$, $p < .01$, respectively), having similar effects for overall students. Interestingly, the gender difference in math achievement was noticed only in the Caucasian group among all ethnic groups. Computer use for schoolwork was pronounced in the Caucasian group, significantly predicting math score ($b = 2.067$, $p < .01$). Computer use to learn on one's own, however, was not significant ($b= -0.138$, $p>.05$). Therefore, when Caucasian male students used computers for schoolwork frequently, they tended to have high math scores. In the 3rd step, neither of two interaction terms was significant.

African-American model

Although the regression model for the African-American group was significant, the amount of the variance explained by the model was comparatively small (Total $R^2 = 0.084$, $p < .01$). At the first step, SES is a significant predictor of math achievement ($b = 3.912$, $p < .01$), as seen in the Caucasian group. Gender difference in math achievement, however, was not detected ($b = -0.697$, $p > .05$). The results of computer use were consistent with those of the Caucasian group. Computer use for schoolwork ($b = 0.935$, $p < .01$) was found significant in predicting math scores for African-American male students, while computer use to learn on one's own was not significant ($b = 0.165$, $p > .05$). Neither of two interaction terms was significant in the third step.

Hispanic model

The regression model for the Hispanic group was significant (Total $R^2 = 0.113$, $p < .01$). SES ($b = 4.895$, $p<.01$) was a significant predictor of math achievement while gender was not ($b= -0.986$, $p >.05$). Both variables of computer use were significant ($b = 0.546$, $p <.05$; $b = 0.743$, $p <.01$). Importantly, computers used to learn on one's own had a significant effect only for Hispanic students. Although no differential effects of gender with computer use for school work on math performance was noticed ($b = 0.267$, $p >.05$), a significant gender effect was found in computer use to learn on one's own on math performance, indicating that the effect of computer use to learn on one's own on math performance in females was significantly lower than in males ($b = -1.076$, $p < .05$).

Asian model

The regression for Asian students had significant results (Total $R^2 = 0.161$, $p<.01$). At the first step, SES was significant ($b = 5.133$, $p < .01$) while gender difference was not detected ($b = -0.035$, $p >.05$). As in other ethnic groups, computer use for schoolwork was significant in predicting math scores for Asian male students ($b = 1.953$, $p <.01$), but computer use to learn on one's own was not found significant ($b= 0.287$, $p > .05$). Similar to the findings in other ethnic groups, the study detected no differential effect of gender in association with computer use for schoolwork. Importantly, the study noticed an effect of gender in computer use to learn on own on academic performance. In other words, the effect of computer use to learn on one's own on math performance was significantly lower for females ($b = -1.465$, $p < .05$).

Native Indian model

The regression of Native Indians was also significant (Total $R^2 = 0.179$, $p<.01$). SES was a significant predictor of math achievement ($b = 3.972$, $p<.01$) while gender difference was not detected ($b = 1.132$, $p>.05$). However, in the Native Indian group, neither computer use for schoolwork ($b = 1.050$, $p >.05$) nor to learn on one's own ($b = 0.727$, $p>.05$) was significant. Interestingly, a significant differential gender effect was found in computer use for schoolwork on math performance ($b = 2.572$, $p < .05$), which was quite different from the results of other ethnic groups. That is, the effect of computer use for schoolwork was significantly higher for Native Indian female students than for male counterparts. However, no differential effect of computer use to learn on one's own was detected.

Discussion and Conclusion

This study attempted empirically to test computer use in diverse learning contexts and to examine the differential effects of race and gender with regard to computer use on math performance. In the analysis of the first model, SES was found significant in predicting math performance for overall 10th grade students. A significant gender difference in math achievement was also found for the overall student group and the Caucasian group. In the second step, computer use for schoolwork was found significant for all students except Native Indian students. On the other hand, computer use to learn on one's own was found significant only for Hispanic students. In the third step, the interaction effect of computer use to learn on one's own with gender was significant for overall students. Therefore, female students' increased frequency of computer use to learn on their own was associated with decreased performance. This tendency was noticed for Hispanic and Asian female students.

In sum, this study showed significant effects of computer use across various contexts on math achievement with SES controlled for. The results of this study could be used for a baseline to suggest the integration of computer use across various contexts into the curriculum. As Erstad (2006) suggested, students' learning with regard to computer use outside the schools should be connected to formal learning. The notion of both informal and formal learning using computers is also well supported by another pedagogy: a learning ecologies framework, in which regard, learning occurs across various contexts including home and school (Barron, Martin, & Roberts, 2007). Based on the results of this study and the suggestions from other researchers, integration of computer use into academic learning should be considered. This study suggests making some provisions to integrate computer uses in both classrooms and other non-formal educational places, in addition to the current main investment to provide more physical access to this technology for schools and communities (Hess & Leal, 2001). The results of this study also may provide a guideline for teachers in regard to the effective use of computers. By being aware of the significant effects of computer use across various contexts, teachers can encourage students to use computers for educational purposes across various contexts. Especially, computer use for schoolwork can be encouraged for almost all students. Teachers, however, need to guide computer use to learn on one's own with caution by considering the differential effects of gender and race. Based on the findings of this study, it is suggested that teachers need to provide more guidance and work more closely with female students, especially Asian and Hispanic students, for computer use to learn on one's own. However, teachers can encourage Hispanic male students to use computers for this purpose more often.

For instructional designers, the results of this study can also provide an insight to make computer use pedagogically effective for students of diverse backgrounds. As the study specified previously, the two computer variables can represent different levels of learner centeredness, which is an important issue in using computers for educational purposes. The significant findings of this study on the effects of computer use for schoolwork for almost all students can be a strong baseline to predict beneficial effects of learner-centeredness when accompanied by proper guidance of teachers or content experts. Therefore, it is important for instructional designers to seek to balance the features for guidance and full learner control when designing learner-centered learning environments.

In addition, the results of this study could imply the differential effects of learner-centeredness on different races and genders. As previously noted, not all learners benefit from learner-centeredness (Hill, Wiley, Nelson, & Han, 2003). Autonomous and independent learners are expected to be more successful, as learners need to be responsible for their own learning in a learner-centered environment (Hannafin & Land, 1997). Caucasian students would prefer working alone while students of other races would prefer working in groups because of cultural differences (Chisholm, 1995). Reflecting this difference, the findings of this study for computer use for schoolwork showed that the effects on Caucasian students were stronger than that of any other races, even though the difference from Asian students was not large.

When the proposed study analyzed the differential effects of learner-centeredness on different races and genders using computer use to learn on one's own, the effect was significant only for Hispanic male students. Current literature on computer use in the context of Hispanic backgrounds reports that the Hispanic group had the lower accessing rate for computers (DeBell & Chapman, 2006) and showed a preference for cooperation and interdependence in learning contexts (Chisholm, 1995). This result suggests that there is room for further research to link computer use in this cultural and social context. In using computers to learn on one's own, the gender difference was pronounced compared with computer use for schoolwork. Overall, the effects of females' computer use on math performance were significantly lower than that of males. Moreover, this gender difference was noticed among Hispanic and Asian students. This effect may be caused by the fact that females preferred communication and interpersonal interaction as learning activities in using computers to working independently (Heemskerk, Brink, Volman, & ten Dam, 2005). This finding can also lead to a suggestion for instructional designers to add features for collaborative group work and communication to accommodate female students engaged in a learner-centered environment.

This study showed the potential of computer use across various contexts as an effective way to use computers for academic purposes. While this study examines two specific computer uses for schoolwork and to learn on one's own, future research should try to identify other learning activities in various learning contexts in order to promote student achievement. Also, future research needs to be done for other domains than math to generalize the results further. This study showed the differential effects of computer use on different genders and races and suggested some ways to counteract potential negative effects for some races and gender. In addition to gender and race with SES controlled for, future research should examine the differential effects for students of differing language proficiency, as some researchers mentioned difficulties in using computers for learning with regard to students of a different language background from the instructional language (Heemskerk, Brink, Volman, & ten Dam, 2005).

Although this study benefits from a well-organized, the USA nationally representative database and a proper statistical analysis, it is important to acknowledge its limitations. The main limitation of the study is that it is not an experimental study in which random assignment makes possible a direct causal-effect link. Therefore, plausible causal-effect association should be interpreted with caution. In that sense, the objective of the study is to provide a better understanding of the effects of computer use with consideration of various contexts, races, and gender.

The researchers hope to stimulate further research using quasi-experimental designs on issues related to computer use in diverse learning contexts based on learner-centeredness.

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