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# ORIGINAL RESEARCH ARTICLE

# The Effects of Computer-Based Learning Activities and School Contextual Factors on Student Math Achievement

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This study investigated the extent to which computer-based learning activities and selected school contextual factors affect student math achievement in high school, using the Educational Longitudinal Study of 2002. In spite of a growing interest in the effect of computer-based learning activities on math performance, few large-scale studies have examined this topic. Given the evidence that computer-based learning activities can be promoted through school principals to a large extent, this study selected principal leadership as a school contextual factor. Additionally, school policy on math course requirements was selected as the other school contextual factor. Multilevel modeling analyses revealed that (a) computer-based learning activities had significant and positive effects on student math achievement and (b) principal leadership played an influential role in improving student math achievement. The results suggest that school principals should support incorporating computer-based learning activities into the math curriculum.

## INTRODUCTION

Identifying factors that affect student academic achievement, particularly in the area of math achievement, has been a long-standing issue in educational research. Based on a wide consensus that mathematics skills are increasingly necessary for the 21st

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Century workforce (Fox, 2003; Vincent, 2005), strategies to improve math achievement now focus more attention to diverse stakeholders than ever before. Owing to research efforts, several learning and demographic factors, including taking advanced math courses and social economic status (SES), have been discovered as strong predictors that affect student math performance. However, there could be other potential factors that impact student math performance that have not been solidified in the literature. Among the potential factors, growing interest concerns the effects of computer-based learning activities on math performance. While computer technology has been incorporated into classroom since the 1990s (Barron, Kemker, Harmes, & Kalaydjian, 2003), few large-scale studies have examined the effects of computer-based learning activities on math performance.

In addition to the computer-based learning activities, as a school contextual factor, this study selected principal leadership because of evidence that, to incorporate computer technology into math curriculum, the support of school principal is essential (Means, 2010). As another school level factor, this study chose school policy on math course requirements because of its lack of research as a potential factor of academic success. To address these issues, this study asks the following two research questions.

## RESEARCH QUESTIONS

The following two research questions guided this study: a) what is the extent to which computer-based learning activities affect student math performance? And b) how do school principal leadership and school policy on math course requirements affect student math performance? The results would provide insight into creating an effective math learning environment and suggest ways in which school principals can support math curriculum design to improve student math performance.

## LITERATURE REVIEW

Since the 1990s, computers have become a necessary tool that we use in our daily lives (Fox, 2003); further, there has been steady and continuous investment in adopting computer technology into K-12 classrooms (Barron et al., 2003; Ruthven & Hennessy, 2002). Accordingly, the ratio of students per computer has been dropped from an average of 10.1:1 in 1995 to 5.4:1 in 2000 (Quality Education Data, 2001). Moreover, a recent report by the U.S. Census Bureau (2011) indicated that the ratio has dropped further to 4:1 as of the 2005-2006 school year. However, for each student to fully participate in computer-based learning activities, the ratio should be 1:1 (Norris & Soloway, 2003).

To achieve one computer for every student in a classroom, there should be more active support at the national, state, and school levels. Implementing a sound computing infrastructure in the K-12 classroom is necessary because students should be used to using computer technology skills to prepare for the 21st Century workforce (Katehi, Pearson, & Feder, 2009). In fact, from 2010 to 2020, employment of all computer occupations is projected to increase by 22% (U.S. Bureau of Labor Statistics, 2012).

In addition to the importance of computer technology skills, there has been growing interests in investigating effects of computer-based learning activities on student academic achievement, particularly in the area of math achievement. A recent meta-analysis of 46 studies on 36,793 learners revealed a significantly positive relationship between computer technology and math performance (Li & Ma, 2010).

However, some studies have showed no significant differences in student math achievement between those who participated in computer-based learning activities and their counterparts. For example, Ke's (2008a) study showed no significant difference between an educational computer game and traditional paper- and pencil drills in math performance of 487 fifth grade students. Ke's (2008b) another study also found no significant effects of computer game on math performance of 15 fourth and fifth grade students. Other large-scale studies (Cabalo, Jaciw, & Vu, 2007; Campuzano, Dynarski, Agodini, & Rall, 2009; Shney-derman, 2001; Smith, 2001) that included 1,723 high school students in 27 schools across 7 districts found no significant effects of an educational computer technology (Carnegie Learning Curricula and Cognitive Tutor® software (CLC & CT®S)* on math performance (Institute of Education Sciences, 2010).

These inconsistent findings suggest the need for more research to explore how computer technology influences math achievement. Such studies should use robust scientific methods to inform the effect of educational technology on math performance to diverse stakeholders including policy-makers and educators and to contribute to documenting the study results in the literature.

In addition to these mixed results on the effects of educational computer technology on math performance, in practice, K-12 public school systems still have barriers to fully incorporate technology into the curriculum because a) a significant amount of cost required to reduce the ratio of computer and student into 1:1; and b) the resistance of public school systems to adopt technology-based learning activities. The later is fueled by the reality that teachers would need to spend more time to become familiar with technology-based instruction by participating in professional development and tailoring computer-based learning to each student's need (Collins & Halverson, 2009).

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*"The combination of the *Carnegie Learning Curricula and Cognitive Tutor® Software* merges algebra textbooks with interactive software developed around an artificial intelligence model that identifies strengths and weaknesses in an individual student's mastery of mathematical concepts. The software customizes prompts to focus on areas in which the student is struggling and routes the student to problems that address those specific concepts" (http://carnegielearning.com/secondary-curricula/, downloaded April 2010).

To overcome these barriers, support by school principals is necessary (Means, 2010). School principals are expected to build partnerships with stakeholders including school policy-makers and those in the private sector who can provide funding sources to fully incorporate computer technology into the K-12 public school systems. Furthermore, school principals play an influential role in encouraging teachers to adopt computer-based instruction. Based on the important roles of school principals, this study chose principal leadership as a school contextual factor.

Additionally, this study selected school policy on math course requirements as a school level factor for analysis. This consideration was based on the assumption that rigorous math course requirements can be helpful to improve student math performance. Another reason why school policy on math course requirements was selected is because of the lack of research on the effects of the school policy on math course requirements on student math performance. In an alignment with the literature review, the next section discusses the conceptual framework of the study.

## CONCEPTUAL FRAMEWORK

Conceptually framed by the pedagogical structure suggested in a seminal text, "*How People Learn: Brain, Mind, Experience, and School"* (Bransford, Brown, & Cocking, 1999), computer-based learning activities were selected in the study as a math learning activity. The pedagogical structure used indicates that people learn based on a combination of diverse learning activities rather than a sole activity. Among the learning activities suggested by Bransford and colleagues (1999), technology-based learning activities, which are less well documented in the literature compared to other traditional learning activities (e.g., individual and lecture-based), was selected for the present study.

Based on the rationale that improving classroom technology infrastructure is substantially determined by school principal' leadership (Means, 2010), this study chose principal leadership as a school level factor. With no doubt, successful principal leadership largely contributes to improving student learning (Leithwood & Jantzi, 2008). However, identifying the essentials of quality leadership to improve student learning outcomes needs further exploration. Specifically, little is known about the effect of distributed leadership on student learning outcomes (Leithwood, Louis, Anderson, & Washlstrom, 2004).

In view of this gap in the literature and with an aim to shed light on the essentials of distributed leadership as a school contextual factor, this study investigated the effects of distributed leadership on student math performance. The principal leadership variable, which mirrored "distributed leadership," consisted of the six sub-variables that represented partnership with community and parents and shared decision-making for the purpose of enhancing student academic achievement and school climate. The details of the six sub-variables were to be addressed in the methods section.

The principal leadership variable that contains these six sub-variables can reflect "distributed leadership," which is based on the idea that distributed leadership is sustained with the active involvement of multiple leaders tailored to different situations, routines, and subject areas (Camburn, Rowan, & Taylor, 2003; Copland, 2003; Spillane, Halverson, & Diamond, 2004). In addition to principal leadership, school policy on math course requirements was included as a school contextual factor, with the assumption that rigorous math course requirements help students improve math achievement.

As control variables, this study included gender and SES. In the proposed multilevel model for the study, gender effect needed to be controlled because of the long-standing problem of a gender gap in math performance, which significantly affects student math performance.

Additionally, student SES is a well known demographic factor that strongly impact student academic achievement in mathematics. Moreover, school level SES drives the level of availability of computer technology facilities. Students in lower SES communities have much less support or opportunity to access computer technology than do students in higher SES communities (Cummins, Brown, & Sayers, 2007). Accordingly, this study controlled both student and school level SES to investigate the effects of computer technology on student academic performance. Significant and positive effects of computer-based learning activities on student math performance would recommend that diverse stakeholders, including school principals, should make efforts to improve the computer technology infrastructure in economically disadvantaged communities.

# METHODS

To answer the two research questions of the study, multilevel modeling was an appropriate statistical method based on the nested structure of the Educational Longitudinal Study of 2002 (ELS 2002). The ELS 2002 has a data structure that shows students are nested within schools. Additionally, the ELS 2002 was designed to access $10^{th}$ grade student academic and psychosocial processes and outcomes longitudinally over three time points (2002, 2004, and 2006; see the detailed description of the ELS 2002 at *http://nces.ed.gov/surveys/els2002/*). Tailoring the nested structure in the dataset, this study examined both within and between school-level factors that affect student math performance using software R (Bates, 2011). In fact, as shown in Table 4, Intraclass correlation (ICC) showed that there was 19.6% variance in student math performance between schools. Based on the proportion of variance explained by the grouping structure (19.6%), conducting a multilevel analysis is highly recommended to estimate the unbiased parameters and standard errors. The following section provides a description of the selected variables and sample participants extracted from the ELS 2002.

## Variables

The major independent variables that this study focused on examining were a) computer-based learning activities within school level and b) principal leadership and school policy on math course requirements between school levels. The other independent variables were the control variables in the proposed multilevel model that were selected to examine the relative effects of the major independent variables. The control variables included a) within school level, gender, student SES, and students' previous math performance and b) between school level, school level SES. The dependent variable was student math performance collected in the first follow up study in 2004. The following sections explain the selected independent and dependent variables from the ELS 2002 in more detail.

### *Computer-based Learning Activities*

The computer-based learning activities in the study were represented by two variables extracted from the ELS 2002. The first variable, labeled "BYS45B" in the ELS 2002, addressed: "How often do you use computers for school work?" The second variable, labeled "BYS45C" in the ELS 2002, asked students: "How often do you use computers for own learning?" These two items were rated on a 5-point Likert scale and anchored with 1 = *never*, 2 = *rarely*, 3 = *less than once a week*, 4 = *once or twice a week*, and 5 = *everyday or almost every day*.

### *Principal Leadership*

The principal leadership variable was created by compiling the following six sub-variables from the ELS 2002: a) Principal evaluated on the performance of their students' standardized test scores; b) Principal evaluated on a good disciplinary environment in the school; c) Principal evaluated on efficient administration; d) Principal evaluated on parent involvement; e) Principal evaluated on relationship with community; and f) Principal evaluated on implementation of new programs or reform efforts, such as shared decision-making. The composite value of these six sub-variables delineated the distributed leadership of school principals because it characterized principals' active involvement in shared leadership by making an effort to build efficient partnerships with parents and community to improve student academic performance.

School administrators (excluding school principals) responded to these six sub-variables using a 3-point Likert point (1 = *No Influence*; 2 = *Minor Influence*; 3 = *Great Deal of Influence*). The composition of these six sub-variables yielded a Cronbach's alpha reliability estimate of 0.67, which is considered a marginally acceptable level.

### *School Policy on Math Course Requirements*

In addition to the principal leadership variable, school policy on math course requirements was selected and defined as the number of math courses required to graduate from high school. This information was collected by school administrators, which was measured on a 4-point Likert scale (4 = *4 Years*; 5 = *5 Years*; 6 = *6 Years*; 7 = *7 Years*).

### *Gender*

Gender was a within school level control variable. Among a total of 2,925 students, female students composed of approximately 49% (1,439). This variable was labeled "BYSEX" in the ELS 2002. In the variable, female students were coded as 1.

### *Student SES*

Student SES was another within school level control variable and was labeled as "BYSES1QU" in the ELS 2002. This variable was classified into the four SES level as follows: a) Lowest quartile SES (coded as 1); b) Second quartile SES (coded as 2); c) Third quartile SES (coded as 3); and d) Highest quartile SES (coded as 4). The SES variable was developed based on parents' (or guardian) income level, parents' (or guardian) education level, and parents' (or guardian) occupation.

### *Student Previous Math Performance*

Student previous math performance, which was selected as the other control variable, was measured by the base year math IRT (Item Response Theory) scores and named "F1TXMBIR" in the ELS 2002. This variable was referred as the number of math items in the math item pool that students gave the right answers for the base year ELS 2002.

### *School Level SES*

School level SES, which was a school level control variable, was developed based on the aggregated value of student level SES by each school. School level SES ranged from a minimum of 1 to a maximum of 4, which has the same description of the student SES.

### *Student Math Performance*

The dependent variable, student math performance was measured using the first follow-up math IRT scores. This variable, named "F1TXMBIR," was collected in the first follow up year (2004) of the ELS 2002.

## Participants

A total of 2,925 students in 316 schools were extracted from the ELS 2002 and had all information on the selected variables in the study. The demographic information of these students was broken down by gender and SES. Female students constituted 49% (1,439) of the sample. SES distribution for each quartile was as follows: a) 17.6% (514) = lowest quartile SES; b) 23.4% (683) = second quartile SES; c) 27.2% (797) = third quartile SES; and d) 31.8% (931) = upper quartile.

# RESULTS

This section first presents the descriptive statistics for the selected student and school level variables. Tables 1-3 show the results. It then presents the results from a multilevel modeling analysis. As described earlier, the first research question asked about the effects of computer-based learning activities on math performance within school levels; the second research question asked about the extent to which the selected school level factors (i.e., principal leadership and school policy on math course requirements) affected student math performance. The multilevel modeling results are presented in Table 4.

## Descriptive Results

The descriptive statistics as shown in Table 1 indicate that the computer-based learning activities ranged from a minimum of 2 to a maximum of 10 with a mean of 6.44 and a standard deviation of 2.03. Students' previous math performance indicates a mean score of 45.69 of the based year math IRT scores, with a standard deviation of 13.52. The minimum and maximum scores were 14.69 and 79.78. The mean score of the first follow up math IRT scores was 51.61 with a standard deviation of 14.78. The scores ranged from a minimum of 17.26 to a maximum of 80.53. Further, the mean value of the student level SES was 2.73 with a standard deviation of 1.09. The student level SES ranged from a minimum of 1 to a maximum of 4.

At the school level, Table 1 shows that the mean value of the principal leadership variable was 15.83 with a standard deviation of 1.83. The minimum and maximum values that school principals obtained were 9 and 18. In terms of school policy on math course requirements, the results show that the average years of math courses required for graduating from the high school were 5.85 with a standard deviation of 0.62. Among 316 schools, 0.2% required 4 years; 27.8% required 5 years; 59.3% required 6 years; 12.7% required 7 years. Further, the mean value of the school level SES was 2.73 with a standard deviation of 0.61. The school level SES ranged from a minimum of 1 to a maximum of 4, which has the same description of the student SES.

Table 2 shows the frequency distribution of computer-based learning activities by gender. As shown in Table 2, overall, it appeared that the frequency level of computer-based learning activities was equally distributed by gender. However, in the lowest level (Level 2), male students were more heavily concentrated than female students (72% vs. 28%), while the opposite situation occurred in the highest levels (Level 9: male 63% vs. female 37%; Level 10: male 56% vs. female 44%).

Table 1
*Descriptive Statistics of the Selected Variables*

| Variables | Mean | Std. Deviation | Minimum | Maximum |
|---|---|---|---|---|
| Computer-based learning activities | 6.44 | 2.03 | 2.00 | 10.00 |
| Principal Leadership | 15.83 | 1.83 | 9.00 | 18.00 |
| School policy on math course requirements | 5.85 | 0.62 | 4.00 | 7.00 |
| Student SES | 2.73 | 1.09 | 1.00 | 4.00 |
| Student previous math performance | 45.69 | 13.52 | 14.69 | 79.78 |
| School level SES | 2.73 | 0.61 | 1.00 | 4.00 |
| Student math performance | 50.61 | 14.78 | 17.26 | 80.53 |
| Total number of student participants | 2,925 | | | |
| Total number of schools | 316 | | | |

Table 2
*Cross-tabulation for Gender and Computer-based Learning Activities*

| Variables | Gender | | |
|---|---|---|---|
| Computer-based learning activities | Male | Female | Total |
| 2 | 76 (72%) | 29 (28%) | 105 (3.59%) |
| 3 | 71(50%) | 71(50%) | 142(4.85%) |
| 4 | 163(54%) | 139(46%) | 302(10.32%) |
| 5 | 157(43%) | 211(57%) | 368(12.58%) |
| 6 | 249(46%) | 288(54%) | 537(18.36%) |
| 7 | 243(49%) | 256(51%) | 499(17.06%) |
| 8 | 238(48%) | 254(52%) | 492(16.82%) |
| 9 | 183(63%) | 109(37%) | 292(9.98%) |
| 10 | 106(56%) | 82(44%) | 188(6.43%) |
| Total | 1,486(51%) | 1,439(49%) | 2,925(100%) |

Table 3 shows the frequency distribution of computer-based learning activities by student SES. As shown in Table 3, not surprisingly, students from the higher SES background had more access to and use of computer than those who were from the lower SES background. The frequency distribution results were consistent with the recent national report published by the National Telecommunication and Information Administration (2008) that indicated that significant gaps in some types of computer access still exist between groups with differential incomes and educational attainment, in spite of steady progress in reducing the gaps.

Table 3

*Cross-tabulation for Student SES and Computer-based Learning Activities*

| Variables | SES Quartile | | | | |
|---|---|---|---|---|---|
| Computer-based learning activities | 1 | 2 | 3 | 4 | Total |
| 2 | 45 (42.86%) | 22 (20.95%) | 22 (20.95%) | 16 (15.24%) | 105 (3.59%) |
| 3 | 28 (19.72%) | 36 (25.32%) | 42 (29.58%) | 36 (25.35%) | 142 (4.85%) |
| 4 | 80 (26.49%) | 76 (25.17%) | 72 (23.84%) | 74 (24.50%) | 302 (10.32%) |
| 5 | 66 (17.93%) | 94 (25.54%) | 106 (28.80%) | 102 (27.72%) | 368 (12.58%) |
| 6 | 92 (17.13%) | 125 (23.28%) | 143 (26.63%) | 177 (32.96%) | 537 (18.36%) |
| 7 | 69 (13.83%) | 127 (25.45%) | 139 (27.86%) | 164 (32.87%) | 499 (17.06%) |
| 8 | 73 (14.84%) | 102 (20.73%) | 145 (29.47%) | 172 (34.96%) | 492 (16.82%) |
| 9 | 29 (9.93%) | 65 (22.26%) | 78 (26.71%) | 120 (41.10%) | 292 (9.98%) |
| 10 | 32 (17.02%) | 36 (19.15%) | 50 (26.60%) | 70 (37.23%) | 188 (6.43%) |
| Total | 514 (17.57%) | 683 (23.35%) | 797 (27.25%) | 931 (31.83%) | 2,925 (100.00%) |

## Multilevel Modeling Results

Table 4 shows the multilevel modeling results. In Table 4, Model 3 with all predictors in the study would be reviewed. Model 3, which has the smallest deviance*, shows the best models among the three models (Model 1 = *null model*; Model 2 = *model with controlling variables*; Model 3 = *model with all predictors*).

As shown in Table 4, in response to the first research question, within school level, taking into account gender, student SES, and student previous math performance, computer-based learning activities had a significant and positive effect on student math performance ($p$ < .05). Students who are more inclined to use computers for their schoolwork and own learning showed better performance on mathematics.

* It is not surprising that the Model 3 shows the smallest deviance, because the deviance is expected to go down through adding explanatory variables to the model.

Also as shown in Table 4, the results suggest that principal leadership significantly affects student math performance, after controlling for school level SES (p < .05). The indicators of principal leadership also reflect distributed leadership. This result suggests that students who study in the schools with principal distributed leadership had a better performance on mathematics. However, school policy on math course requirements did not show significant effects on student math performance, although it was positively associated with student math performance.

Table 4

*Multilevel Modeling Results*

| | Model1 | Model 2 | Model 3 |
|---|---|---|---|
| Dependent Variable: First Follow Up IRT Math Score | | | |
| **Variables** | **Coefficient (S.E.)** | | |
| **Fixed Effect** | | | |
| Intercept | 50.67**(0.45) | 3.51(0.63) | -1.54 (1.93) |
| *Student Level* | | | |
| Base Year IRT scores | | 0.97**(0.01) | 0.97**(0.01) |
| SES_Student Level | | 0.63**(0.12) | 0.61**(0.12) |
| Gender | | -0.84**(0.22) | -0.87**(0.22) |
| Computer Use in Own Learning and School Work*** | | | 0.14*(0.05) |
| *School Level* | | | |
| SES School Level | | 0.53**(0.24) | 0.53*(0.24) |
| Principal Leadership (Distributed leadership) | | | 0.16*(0.07) |
| School Policy on Math Course Requirements | | | 0.29 (0.23) |
| **Random Effect** | | | |
| Intercept | | 0.00 | 159.39 |
| School Level SES | | 0.21 | 0.05 |
| Principal Leadership | | | 0.08 |
| School Policy on Math Courses | | | 1.71 |
| Residual Variance | | 33.14 | 33.00 |
| Intraclass Correlation (ICC) | 19.6% | | |
| Deviance | 23,800 | 18,649 | 18,627 |
| Number of Students in the Analysis | 2,925 | | |
| Number of Schools in the Analysis | 316 | | |

*Note*. * p<.05; **p<.01; *In this table, numbers in parenthesis indicate standard errors.*
****This variable is a composite variable of BYS45B and BYS45C.*

# DISCUSSION AND CONCLUSIONS

The results of the study can be summarized as follows: a) computer-based learning activities are helpful for students to enhance their academic achievement in mathematics at the student level; and b) at the school level, successful principal leadership, which can be characterized as distributed leadership, is positively and significantly associated with student math performance. A synthesis of the results of research questions 1 and 2 suggests that school principals play an important role in improving computer technology infrastructure in classrooms and supporting teachers to pursue a progressive math curriculum by integrating technology into the traditional math curriculum. To adopt such progressive math learning activities, school principals are encouraged to establish partnerships with a wide range of stakeholders from policy makers to private sectors who can potentially provide funding for educational technology in student math learning. Developing such partnerships characterizes the essentials of distributed leadership in the areas of supporting educational technology and improving student math performance.

Every student should have equal educational opportunity to access computer technology; however, school principals in low SES communities would experience a greater challenge in setting up sufficient computing infrastructure in classrooms than those in middle or high SES communities. To achieve equal educational opportunity, regardless of student SES, more financial support at the state and national levels is necessary to allow school to build competitive technology-based learning environment in low SES communities.

In addition to principals' efforts to securing funding for computer technology infrastructure, school principals should encourage and support teachers to participate in professional development to integrate computer technology into traditional math classrooms. As addressed previously, teachers must spend extra time developing innovative computer-based curriculum and providing instructional support that is tailored to different needs and interests of students. With no doubt, school principals play a large role in empowering and motivating teachers to make such extra efforts to successfully incorporate computer-based learning activities into traditional classrooms.

With regard to future research studies, it would be informative to investigate the detailed contents of computer-based learning activities in mathematics. This study admits the limitation that the ELS 2002 did not detail the selected variables that defined computer-based learning activities. Thus, a subsequent study needs to focus on detailing computer-based learning activities by designing a computer-based math curriculum and examining the effects of the designed curriculum on student math performance. Importantly, given the result that female students showed lower performance in math than did male students, educators are encouraged to consider gender differences when designing curriculum; particularly in terms of motivating female students to engage in math learning through the computer-based curriculum.

Based on the positive effects of principal leadership on student math performance, it would be valuable to investigate the extent to which student math performance across schools differs between school principals who are actively involved in supporting computer-based learning and those who are not.

Moreover, a follow up study that focuses on the transition from high school to postsecondary education could develop the multilevel structural equation modeling necessary to demonstrate how computer-based learning activities within school levels and principal leadership between school levels influence student college access via student math performance. Regarding student college access, because computer-based learning activities are relevant to Science, Technology, Engineering, and Math (STEM) majors (Shaffer, 2007), it would be useful to study the extent to which computer-based learning activities affect students' STEM major choices. Given the dire problem that there is a lack of STEM workforce, many scholars have investigated factors that affect STEM major choices. However, few studies have examined the relationship between STEM-related tasks or activities and STEM major choices. Beyond STEM major choices, it would be informative to longitudinally monitor the effect of computer-based learning activities at the K-12 levels on students' Bachelor degree attainments and employment in STEM fields, with specific attention to specific demographic characteristics (e.g., gender, race/ethnicity, and disability status).

Beyond computer-based learning activities and principals' distributed leadership, there might other potential learning and school contextual factors that contribute to positive student learning outcomes. Educational scholars need to examine these potential factors and new findings from such studies should be helpful in improving student educational environments. Educational research should aim to create better educational environments that offer equal educational opportunities for all students. With this aim, research in education should focus on helping challenging students including those from low SES background and students with disabilities who are often vulnerable in our society.

# REFERENCES

Bates, D. (2011). *Examples from multilevel software comparative reviews*. Retrieved from http://cran.r-project.org/web/packages/mlmRev/vignettes/MlmSoftRev.pdf

Barron, A. E., Kemker, K., Harmes, C., & Kalaydjian, K. (2003). Large-scale research study on technology in K-12 schools: Technology integration as it relates to the national technology standards. *Journal of Research on Technology in Education. 35*(4). 489-507.

Bransford, J. D., Brown, A. L., & Cocking, R. R. (Eds.). (1999). *How people learn: Brain, mind, experience, and school*. Washington, D.C.: National Academy Press. Retrieved from http://www.nap.edu/openbook.php?record_id=6160

Bureau of Labor Statistics (2012). *Occupational outlook handbook.* Retrieved from http://www.bls.gov/ooh/computer-and-information-technology/computer-and-information-research-scientists.htm#tab-6

Cabalo, J. V., Jaciw, A., & Vu, M. T. (2007). *Comparative effectiveness of Carnegie Learning's Cognitive Tutor Algebra I curriculum: A report of a randomized experiment in the Maui School District*. Palo Alto, CA: Empirical Education, Inc.

Camburn, E., Rowan, B., & Taylor, J. E. (2003). Distributed leadership in schools: The case of elementary schools adopting comprehensive school reform models. *Educational Evaluation and Policy Analysis. 25*(4). 347-373.

Campuzano, L., Dynarski, M., Agodini, R., & Rall, K. (2009). *Effectiveness of reading and mathematics software products: Findings from two student cohorts.* Washington, DC: U.S. Department of Education, Institute of Education Sciences.

Collins, A., & Halverson, R. (2009). *Rethinking education in the age of technology: The digital revolution and the schools*. New York: Teachers College Press.

Copland, M. A. (2003). Leadership of inquiry: Bbuilding and sustaining capacity for school improvement. *Educational Evaluation and Policy Analysis. 25*(4). 375-395.

Cummins, J., Brown, K., & Sayers, D. (2007). *Literacy, technology, and diversity: Teaching for success in changing times.* Boston: Allyn & Bacon.

Fox, M. A. (2003). *Pan-organizational summit on the U.S. science and engineering workforce: Meeting summary*. The National Academy of Science. Retrieved from http://www.ncbi.nlm.nih.gov/books/NBK36359/pdf/TOC.pdf

Institute of Education Sciences. (2010). *What works clearinghouse: Carnegie Learning Curricula and Cognitive Tutor® software*. Retrieved from http://ies.ed.gov/ncee/wwc/pdf/intervention_reports/wwc_cogtutor_083110.pdf

Katehi, L., Pearson, G., & Feder, M. (2009). *Engineering in K-12 education: Understanding the status and improving the prospects*. The National Academies. http://www.nap.edu/catalog.php?record_id=12635

Ke, F. (2008a). Computer games application within alternative classroom goal structures: Cognitive, metacognitive, and affective evaluation. *Educational Technology Research and Development*. 56(5). 539-556.

Ke, F. (2008b). A case study of computer gaming for math: Engaged learning from gameplay? *Computers & Education. 51*(4). 1609-1620.

Leithwood, K., & Jantzi, D. (2008). Linking leadership to student learning: The contributions of leader efficacy. *Educational Administration Quarterly. 44*(4). 496-528.

Leithwood, K., Louis, K. S., Anderson, S., & Wahlstrom, K. (2004). *How leadership influences student learning*. Review of Research. Retrieved from http://mt.educarchile.cl/MT/jjbrunner/archives/libros/Leadership.pdf

Li, Q., & X. Ma (2010). A Meta-analysis of the effects of computer technology on school students' mathematics learning. *Educational Psychology Review 22*(3). 215-243.

Means, B. (2010). Technology and education change: Focus on student learning. *Journal of Research on Technology in Education. 42*(3). 285-307.

National Telecommunications and Information Administration. (2008). *Households using the internet in and outside the home, by selected characteristics: Total, urban, rural, principal city, 2007*. Retrieved from http://www.ntia.doc.gov/reports/2008/Table_HouseholdInternet2007.pdf

Norris, C., & Soloway, E. (2003). The viable alternative: Handhelds. *School Administrator. 60*(4). 26-28.

Quality Education Data. (2001). *Technology purchasing forecast 2000-2001. (6th Ed.)*. Denver, CO: Quality Education Data.

Ruthven, K., & Hennessy, S. (2002). A practitioner model of the use of computer based tools and resources to support mathematics teaching and learning. *Educational Studies in Mathematics. 49*. 47-88.

Shaffer, D. W. (2007). *How computer games help children learn*. New York: Palgrave Macmillan.

Shneyderman, A. (2001). *Evaluation of the cognitive tutor Algebra I program*. Unpublished manuscript. Miami, FL: Miami-Dade County Public Schools, Office of Evaluation and Research.

Smith, J. E. (2001). *The effect of the Carnegie Algebra tutor on student achievement and attitude in introductory high school algebra*. Unpublished doctoral dissertation. Virginia Polytechnic Institute and State University, Blacksburg.

Spillane, J. P., Halverson, R., & Diamond, J. B. (2004). Toward a theory of leadership practice: a distributed perspective. *Journal of Curriculum Studies, 35*(5). 533-543.

U.S. Census Bureau. (2011). *Newsroom: Profile America facts for features*. Retrieved from http://www.census.gov/newsroom/releases/archives/facts_for_features_special_editions/cb11-ff15.html

Vincent, E. T. (2005). *Foundational skills are key to success in the workplace*. ACT. Retrieved from http://www.greatplains.edu/wp-content/uploads/2009/09/FoundationalSkills.pdf