# Relationships Among Computer Self-Efficacy, Professional Development, Teaching Experience, and Technology Integration of Teachers

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# Abstract

This exploratory, mixed-methods study builds upon previous research to focus on the relationships among computer self-efficacy and technology integration in high school mathematics and science teachers in a Midwestern metropolitan area. This population was purposefully sampled to examine factors that influence technology integration among secondary education teachers. These factors were self-efficacy beliefs, professional development, and teaching experience. Data were collected from teachers who volunteered to participate in the study through surveys, semi-structured interviews, classroom observations, and teaching materials. The data were analyzed quantitatively and qualitatively to determine whether relationships existed among the factors under consideration, as well as to detect other patterns. A moderate, statistically significant relationship was found to exist between perceptions of computer self-efficacy and technology integration among the participants. This quantitative finding was supported by qualitative analysis of the teacher interviews, field observations, and curricular documentation and led to the conclusion that perceived computer self-efficacy and perceived technology integration in the classroom are related. No statistically significant correlations were found to exist among the reported weeks of professional development or years of teaching experience with either computer self-efficacy or technology integration. The results can inform future research, as well affect professional development, continuing education, technology training, and teacher education programs.

# Investigating the Relationships Among Computer Self-Efficacy, Professional Development, Teaching Experience, and Technology Integration of Teachers

## Introduction

The United States faces a future that requires an increasing number of college graduates to retain its competitive position in a global economy. Reports on the current state of education in the U.S. urge drastic increases in the quantity and quality of college graduates, especially for the mathematics, science, and engineering areas (Committee on Prospering in the Global Economy of the 21st Century, 2007; Barron, 2003; Glenn, 2000; Kirsch, 2007). The U.S. Domestic Policy Council reported (2006) that for the nation to maintain its position in a global economy, it "…must ensure a continuous supply of highly trained mathematicians, scientists, engineers, technicians, and scientific support staff as well as a scientifically, technically, and numerically literate population" (p. 15).

### *Purpose of the Study*

Using the findings of previous studies as a foundation, the purpose of this study was to examine whether a relationship exists among the perceived *computer* self-efficacy of teachers and their perceived integration of educational technology in their classrooms, as well as professional development and teaching experience.

The significance of determining whether and to what extent these relationships exist could be far-reaching. Greater focus on assessing teachers' attitudes and beliefs during professional development could result in a higher transfer of skills and knowledge to classroom practice. Instruments assessing teacher computer self-efficacy could be incorporated into programs that prepare pre-service teachers and interns. Greater emphasis could be placed on modeling positive attitudes and beliefs with educational technology integration in professional development and teacher education programs. Greater attention may be given to the affective attributes of future teachers that will enable them to become more effective facilitators of technical literacy, which may result in increasing the numbers of U.S. graduates who seek either careers or higher education in the science, technology, engineering, and mathematics (STEM) areas.

Because using educational technology can increase the impact and effectiveness of learning activities in the classroom (Kulik, 2003), the findings of this study can result in renewed focus on increasing teacher confidence and comfort in that use. Technological literacy for all students as a means of equipping them to compete with an increasingly sophisticated global workforce is a founding principle of standards produced by, for example, the International Technology Education Association (ITEA) and the International Society for Technology in Education (ISTE); therefore, it is important to foster the development of teachers who are committed to engendering such literacy.

*The Role of Computer Self-Efficacy in Technology Integration*

In order for educational technology to be implemented in meaningful ways, teachers and students need access to that technology for curricular use. In addition to access, persistence is often necessary to overcome the internal and external barriers to technology integration. People with high computer self-efficacy was found in the pilot study to be more persistent and ingenious in finding ways to incorporate educational technology in authentic learning experiences (Hall, 2008a). It may be necessary to embed in our professional development and teacher education programs means of helping learners to develop strong computer-self efficacy to overcome these barriers.

*The Relationship Between Self-Efficacy and Other Teacher Attributes*

The levels technology integration can vary depending on the context in which it takes place (Bandura, 1977; Coleman, 2004; Herman, 2002; Lorsbach & Jinks, 1999; Lumpe & Chambers, 2001; Pajares, 1997; Rackley, 2004; Whitehead, 2002). Levels of integration can also vary depending on whether technology is used primarily to deliver instruction (Bauer, 2002; Moersch, 1995), or whether it is integrated primarily to augment or improve instruction (Bansavich, 2005; Combs, 2003; Kulik, 2003; Ross, Hogaboam-Gray, & Hannay, 2001).

*The Impact of Other Variables*

The grade level taught, the content area, the experience level of the teacher, and professional development may also affect the relationship between teacher self-efficacy and integration of technology. The level of technology integration needed and the extent of that integration mandated by national and state standards in grades 9 through 12 is much greater than that required at elementary levels. The number of years of experience of teachers has been shown in some studies to have an inverse relationship with self-efficacy, with “newer” teachers reporting higher levels of self-efficacy in regards to technology (Kemp, 2002). However, improvements in technology integration into teacher education programs and the growing pervasiveness of technologies in recent graduates’ classrooms in general may be a factor.

*Need for Current Study*

Although significant relationships between computer self-efficacy, the nature and extent of professional development provided to teachers, years of teaching experience, and the integration of technologies in the classroom have been shown to exist, they have not always been examined together in the same study. A study was needed that focused on these four aspects in particular.

*Research Question*

The primary research question addressed in this study was whether a relationship existed among the integration of educational technology in the teaching of in-service, practicing teachers with computer self-efficacy, weeks of professional development, and years of teaching experience. Based on the literature review and pilot study, the focus of this research was on establishing first whether beliefs and practices as reported on the self-assessments would be correlated and, if such correlation existed, which areas of beliefs showed the stronger correlation to the integration of technology. These correlations could then be compared with the other independent variables of teaching experience and professional development to determine whether any one of these variables would be found to have the stronger relationship.

## Research Design and Methods

The factors previous research suggested influenced the integration of technology by teachers included teacher beliefs regarding the use of technology in classrooms and their practices around the integration of technology (Ertmer, Ottenbreit-Leftwich, & York, 2007). For this reason, a unique design utilizing previously developed but unrelated instruments was created. The teachers' self-reported beliefs about their technology integration were collected using the Computer Self-Efficacy Survey (CSE), an instrument used and validated by Albion (2001). The teachers' perceptions of how they integrated technology were collected using the Technology Integration Self-Assessment (TISA), an instrument developed and validated by Mills (2000). Other evidence beyond perceptions was a key feature of the research design. Evidence of integration of technology was also sought by collecting participants' written lesson plans, and observed evidence of technology integration also took place using the Technology Integration Standards Configuration Matrix (TISCM), also validated by Mills (2003).

The factors emerging from the literature review and pilot study as likely contributors to overall technology integration were computer self-efficacy, the number of years of teaching experience, and the amount of professional development related to technology (Hall, 2008b). The study took place over approximately three months with in-service secondary science, math, and technology teachers in schools in a large Midwestern metropolitan area. The research design included a qualitative approach, since several studies have urged a greater emphasis on the teacher as an agent of change when studying the integration of technology into the classroom (Bitner & Bitner, 2002; Zhao & Frank, 2003) . Teachers' beliefs about their ability to effectively use educational technology or their computer-self efficacy and their current level of integration of such technology in their classroom instruction were measured. In addition, follow-up interviews and classroom observations were conducted to determine whether the self-assessments matched observations and interview data. Field notes and interviews were utilized to minimize researcher bias, as well as to detect patterns that might otherwise have been overlooked, as recommended by Patton (2002). Finally, information regarding teaching experience and professional development was captured for qualitative assessment and their expository support of quantitative findings.

*Population*

High schools in two comparable school districts were selected and assigned pseudonyms for purposes of summarizing findings. The high school with the pseudonym "Willow" listed on its published fact summary 130 high school teachers. The school district assigned the pseudonym "Pine" listed on its published fact summary 125 high school teachers. The comparable faculty size supported the comparisons of the use of these two school districts in examining the integration of educational technology in the classroom. The district expenditure per pupil was listed as more than $12,000 per year in both schools. The study solicited participation from teachers of mathematics and science courses in these schools. The purposeful sampling from school districts within the same metropolitan area and in close proximity to each other ensured contextual relevance of teachers' experiences to pre-service teacher education and to professional development programs in the study area.

Of the 88 teachers at the two schools who were invited to participate in the study, 20 volunteered. Of these 20, 17 participants completed the study within the data collection period. Participants were assigned a unique study code number, such as P0402, and a unique, gender-free pseudonym, such as Lee, that was used to refer to them throughout their participation, and which was used to identify and correlate the instruments, interviews, and observations upon transcriptions and data entry.

*Interviews*

Semi-structured interviews were conducted with the participants using a digital voice recorder and a five-question interview guide derived from the pilot study that asked such questions as: How do you like to integrate technology in your classroom? Why do you think technology helps students to learn? Do you think your participation in professional development helped you to integrate technology in your classrooms?

Interviews were recorded and transcribed, and the aggregated data analyzed using open coding. Field notes were taken before, during, and after the interviews to provide contextual relevance as well as to establish voice and perspective to the findings.

*Observations and Lesson Plans*

Participants were observed teaching a class in which they integrated technology at a time and location they selected. The researcher wrote field notes before, during, and after the approximately 50-minute class periods. The observations focused on the participants' integration of technology and were compared to lesson plans that were provided by the participants. The TISCM instrument was used during observation that corresponded to the participants' self-reported assessment of their use of technology in the classroom using the TISA. This provided a consistent, structured way to compare observations as well as to verify participants' self-perceptions of technology use in the classroom.

*Other Variables*

Previous studies suggested that teachers need three to five years of teaching experience to effectively integrate technology (Byrom & Bingham, 1998). For this reason, the number of years of teaching experience for each participant was gathered as part of the self-assessment, along with the number of weeks of professional development related to technology that the teacher stated they had received.

*Independent and Dependent Variables*

The independent variables in this study were the perceived computer self-efficacy, years of teaching experience, and weeks of professional development of the teacher participants. Based on previous studies, the participants of this study were anticipated to represent a range of experience. Therefore, years of teaching experience were collected at the beginning of the study as part of the computer self-efficacy self-assessment. The dependent variable of perceived technology integration in the classroom was expressed in terms of the score received on the instrument used to capture this data (the TISA). Weeks of professional development training received by the participants were collected as part of the technology integration self-assessment.

*Instruments*

A version of Delcourt & Kinzie's (1993) computer self-efficacy instrument was modified to add questions and was used in a study by Albion (2000) of teacher education students. The resulting instrument gathers perceptions of self-efficacy along several dimensions of use as well as general attitude toward technology.

As previously mentioned, two instruments were used for determining the extent to which teachers integrated technology. The Technology Integration Self-Assessment (TISA) which was validated and used by permission of the author (Mills, 2000). The instrument lists statements designed to determine technology integration practices used in curricular activities. Each statement is accompanied by five subsequent statements that indicate the degree to which a technology has been integrated, in decreasing order of complexity, and including a final choice “None of the above.” Participants chose one or more of the subsequent statements to indicate the degree to which they integrated one of 18 practices, or they could choose the final item to indicate that they did not integrate that particular technology or practice in their curricular activities. This instrument was modified to include an item requesting the number of weeks of professional development, which did not affect its established validity or reliability.

Observations were recorded as field notes, and teachers were rated to indicate the degree to which they were observed integrating technology in curricular activities using the TISCM instrument, created by Mills (2003), corresponding to the TISA in every respect, except the practices are arranged into a grid that identifies those practices associated with international and national technology integration standards and ranging from Ideal to No Use. This TISCM instrument was also used without modification by permission of the author.

Four participants, two from each school, were interviewed using a semi-structured interview guide. Lesson plans were also collected from teachers who were observed to verify that the use of technology in the lessons was planned.

### *Quantitative Analysis*

The participant responses to the self-assessments were analyzed using quantitative analysis, resulting in descriptive statistics that are described in the results. These results of collected data from the administered instruments were triangulated with qualitative data to detect obvious patterns or discrepancies.

## Results

Naturalistic inquiry and open coding were used for transcription, field note, and observation note analyses (Strauss & Corbin, 1998; Patton, 2002). Questionnaire data were analyzed using descriptive statistics and analysis of variance (Gravetter & Wallnau, 2004).

*Qualitative Analysis*

The indexed interview data from participants P0304 and P0304 with the pseudonyms Chris and Jamy from Pine High School, and from participants P0406 and P0407 with the pseudonyms Lee and Lynn from Willow High School were analyzed to determine emergent themes as recommended by Strauss & Corbin (1998). Summary data derived from the interviews provided were arranged into a table that listed each interview question and the summarized participant responses. From that data, themes were identified and indexed phrases classified as either supporting participant integration of technology, or statements supporting participant beliefs about technology.

Support of Technology Integration

There were 62 statements from the combined participant interviews that were classified into 24 themes providing evidence of the participants' integration of technology. These 24 themes were collapsed into 13 categories of use ranging from troubleshooting to classroom hardware and equipment.

Participants' indexed responses were counted to determine the number of times they uttered phrases that supported the integration of technology in their classroom or in their teaching activities, as summarized in Table 1.

**Table 1.** *Participant Totals of Indexed References to Technology Integration and Beliefs*

| Participant | Pseudonym and School | Technology Integration | Belief References |
|---|---|---|---|

| | | | |
|---|---|---|---|
| | | References | |
| P0403 | Chris from Pine | 17 | 17 |
| P0404 | Jamy from Pine | 10 | 17 |
| P0406 | Lee from Willow | 15 | 26 |
| P0407 | Lynn from Willow | 20 | 35 |

Participant P0407 (Lynn) made the greatest number of references to technology use. Lynn taught a science course in a classroom equipped with an instructor desktop computer, an electronic whiteboard, and personal response system devices. There were no computers available for use by the students in the classroom, but a shared computer laboratory was available for scheduled use by students. The least number of references were made by Participant P0404 (Jamy). Jamy taught a science course in a traditional classroom equipped only with an instructor desktop computer; electronic instruments were available to students using a portable cart.

Evidence of Beliefs

There were 97 phrases indexed from the four participant interviews that were classified into themes providing evidence of the participants' beliefs surrounding the integration of technology. The 17 themes emerging from this analysis ranged from beliefs about barriers and enablers to beliefs about student benefits. The 17 themes were collapsed into 8 categories of beliefs, ranging from technology integration in general to the use of electronic books in particular.

The participants' indexed responses were counted to determine the number of times they uttered phrases that supported beliefs about technology in their classroom or in their teaching activities. As summarized by Table 1, Participant P0407 (Lynn) made the greatest number of statements indicating beliefs about the integration of technology. As mentioned previously, Lynn taught a science course at Willow High School in a classroom with an instructor desktop computer, an electronic whiteboard, and personal response system devices.

Participants P0403 (Chris) and P0404 (Jamy) made the smaller number of belief statements about technology. These participants both taught at Pine High School. Jamy was observed teaching in a classroom with an electronic whiteboard, student computers, and electronic laboratory equipment. Chris was observed teaching in a traditional classroom with an instructor desktop computer and with electronic laboratory equipment brought into the room on a portable cart.

*Quantitative Analysis*

The participant responses to the TISA and CSE were input into tables for analysis using SPSS 15.0 for Windows Student Version. The means of the participant scores on the two instruments were computed, and are shown in Table 2. The CSE values were computed by the sum of the scores divided by the total number of questions in those sections of the instrument. The converted values of the TISA responses ranged from 0 to 15. To make these categorical variables comparable to the continuous CSE values, which ranged from 1 to 4, the mean values of each TISA response were scaled by dividing them by 4 (16/4), resulting in the values shown in Table 2.

**Table 2.** *Mean Computed Values of CSE and TISA Responses*

| **Participant** | **CSE Averaged Means** | **TISA (Scaled)** |
|---|---|---|
| P0402 | 3.96 | 3.31 |
| P0403 | 3.90 | 2.54 |
| P0404 | 3.91 | 3.38 |
| P0405 | 3.81 | 3.24 |
| P0406 | 3.52 | 1.35 |
| P0407 | 3.84 | 1.74 |
| P0408 | 3.12 | 1.51 |
| P0409 | 3.63 | 2.12 |

| Participant | CSE<br>Averaged Means | TISA (Scaled) |
|---|---|---|
| P0410 | 2.68 | 2.38 |
| P0411 | 3.75 | 2.25 |
| P0412 | 2.76 | 0.99 |
| P0413 | 3.46 | 1.79 |
| P0414 | 3.72 | 1.32 |
| P0415 | 3.03 | 1.21 |
| P0416 | 3.83 | 1.50 |
| P0418 | 2.95 | 1.15 |
| P0419 | 3.33 | 1.46 |

After examining the mean computed values, it was determined that two types of statistical procedures could be used to look for relationships. Examination of the component statistics using histograms revealed that none were normally distributed. Within the CSE instrument, numerous variations occurred among the seven different dimensions. In addition, the TISA responses were multi-modal, which would contra-indicate parametric analysis based on an assumption of normal distributions. With a non-normal distribution, a nonparametric method of analysis such as Spearman correlation could be used as recommended by Gravetter and Wallnau (2004) to examine whether a relationship existed between the TISA and the CSE scores of the participants. On the other hand, since the sample size was small (n=17) and drawn from a population that could be assumed to demonstrate a Gaussian distribution, a parametric test such as the Pearson correlation could be used, particularly since a nonparametric test would lack statistical power.

To resolve this tension between whether parametric or nonparametric tests should be used, both types were run. A parametric correlation was used to examine the relationships among the averaged cumulative CSE scores and the TISA averaged scores for each participant. A null hypothesis was formed that no relationship between the TISA and the average of all dimensions of the CSE would be found. The dependent variable for this analysis was the TISA scores, where the TISA scaled variable shown in Table 3 was the computed value for the participants' scores on the TISA. The independent variable was the averaged CSE score across six dimensions. One of the dimensions was excluded from analysis of the CSE. This dimension queried participants' perceptions of use regarding E-mail and the sample yielded a constant value of 4, meaning all the participants scored 4 on all parts of that section.

As a result of analysis, the null hypothesis was rejected since the Pearson correlation resulted in .559 ($r = 0.56$), which was significant at the .01 level on a one-tailed t test ($p = 0.01$). Pearson correlations can range from .00 (very weak) to 1.00 (very strong), so a finding of .60 (rounded) provides evidence of moderate strength.

The nonparametric Kendall tau correlation test was also computed for the TISA averaged scaled scores and the CSE averaged scores, with the result of .529 ($r = 0.51$), with significance at the 0.01 level in a two-tailed test ($p = .01$). Again, the null hypothesis was rejected. The Kendall tau test was selected over the Spearman rho based on the number of samples ($n < 20$). However, the Spearman correlation was also computed, yielding a correlation value of .647 ($r = 0.65$) with significance at the 0.01 ($p = .01$) level.

In order to answer the research question of which of the variables--computer self-efficacy, professional development, and years of teaching experience--had the stronger correlation with TISA, the parametric Pearson correlation was repeated on each, with the results shown in the combined correlational matrix summarized in Table 3. No significant

**Table 3.** *Correlational Matrix Comparing TISA, CSE, Teaching Experience, and Professional Development*

| | TISAScaled | CSEAveraged | Years of Teaching Experience | Weeks of Prof. Development |
|---|---|---|---|---|
| | | | | |
| | | | | |
| Experience | 16 | 16 | 16 | 13 |
| Development | | | | |

Correlation is significant at the 0.05 level (2-tailed).

correlations among weeks of professional development, years of teaching experience, and TISA resulted.

## Conclusions and Other Generalizations

A statistically significant relationship between perceived computer self-efficacy and perceived technology integration was found. A comparison of TISA self-reported scores was performed against TISCM scores obtained as a result of classroom teaching observation. A close relationship was found between the perceptions of the participants about their practices, and the perceptions of the observer, suggesting that the participants accurately reported their use of technology in the classrooms.

Triangulating the quantitative results with qualitative data from the interviews offered additional evidence of relationships among the variables. Some of these were counter-intuitive, and are summarized in Table 4. As illustrated, Participants P0404 and P0403, with the lowest number of verbal references to technology integration during the interview, had the highest levels of both self-perceived and observed use of technology.

**Table 4.** *Comparison of TISA and TISCM to Interview References to Technology Integration*

| Participant | TISA Sum | TISCM Score | Interview References to Technology Integration |
|---|---|---|---|
| P0403 | 173 | 45 | 17 references |
| P0404 | 230 | 44 | 10 references |
| P0406 | 92 | 31 | 15 references |
| P0407 | 118 | 48 | 20 references |

The quantitative analysis resulted in a moderate, statistically significant correlation between teachers' perceptions of their computer self-efficacy and their integration of technology in their teaching and learning activities. The additional data collected in interviews, observations, field notes, and lesson plans supported the self-reported instrument data and offered additional insights into the current attitudes, behaviors, and perspectives of practicing teachers toward technology in high school math and science classes.

*Further Discussion of the Study and Recommendations for Future Research*

The reader is cautioned against generalizing the results due to the small size and other limitations of the study. However, the results do suggest that the research question of whether a relationship between perceived computer self-efficacy and perceived levels of technology integration among teachers of science and mathematics in two suburban schools can be answered affirmatively. The results further suggest that perceptions of technology integration do not have a statistically significant relationship with years of teaching experience or weeks of professional development. No significant relationship among the number of years of teaching experience and weeks of professional development with the CSE scores of the participants was found.

The scope of this study was limited to teachers of science and mathematics courses in two, suburban high schools in the Midwest. Participation from the two schools was not take place in proportionate quantities, limiting comparisons among the schools. Some teachers participated in one part of the study without participating in another. This placed heavier than expected focus on the quantitative results.

The factors that the literature review had indicated might act as independent variables on technology integration included age, teaching experience, professional development, and gender. During the administration of the instruments that collected this data, participants had questions about these variables limited the usefulness of their responses. In future research, care would be taken to more completely specify whether participants should provide the number of weeks of professional development received over a stated time period, and the term “technology-related” would be more narrowly defined.

Interview data collected from four of the participants are reported in the findings of the dissertation resulting from this study (Hall, 2008b) and confirmed findings from the pilot study. The value of including lesson plans as additional evidence for technology integration was evident in the case of one participant. This teacher did not use a relatively large number of terms to describe or talk about technology, but was observed to use a variety of technologies in the classroom, and this use was integrated into the lesson plan.

This investigation into the relationships among factors that influence teachers’ use of educational technology can provide critical information that can benefit students and better equip them to compete in a global economy. The conclusions drawn by examination of the results of this study support the perspective that technology is more than just a vehicle for delivering information or transporting knowledge from teacher to student. In the hands of knowledgeable teachers who are confident that the use of technology will result in benefits for their students and benefits to them, educational technology can excite students and teachers in the critical disciplines of sciences and mathematics.

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