# Promoting Constructivist Uses of Technology Through Professional Development

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ABSTRACT

The purpose of this study was to evaluate the effectiveness of a professional development program—Integrating Strategies and Technology in Education Practice (InSTEP™). The objective of InSTEP is to provide teachers with constructivist teaching strategies and methods for integrating a variety of technical software into educational curriculum while providing them with ongoing support. Our results showed that after the completion of the InSTEP program, teachers' technical skill, attitudes toward technology, constructivist teaching strategies, constructivist teaching philosophy, and constructivist uses of technology increased significantly. Furthermore, the InSTEP workshop had a direct effect on teachers' technical skills and their constructivist teaching strategies which then affected teachers' constructivist teaching philosophy and attitude toward technology. These factors together (technical skill, constructivist teaching strategies, attitude toward technology, and constructivist teaching philosophy) accounted for 50 percent of the variance for the teachers' constructivist uses of technology. We conclude that technology integration must be done within the framework of constructivist teaching and that these factors should be the focus of professional development efforts in the future.

## INTRODUCTION

Technical skill and constructivist teaching occur simultaneously to influence technology integration (Hooper & Rieber, 1995; Becker, 2000; Dwyer, Ringstaff, & Sandholtz, 1991). However, training has focused on how to use the hardware (55 percent) and software (30 percent), but not how to integrate these tools into educational curriculum (15 percent) (Cole, 2000; U.S. Congress, 1995). The purpose of Integrating Strategies and Technology in Education Practice (InSTEP™) is to provide teachers with constructivist teaching strategies and methods for integrating a variety of technical software into educational curriculum. We propose that InSTEP will directly increase the technical skill and constructivist teaching strategy of educators. That in turn will increase educators' positive attitudes toward technology and constructivist teaching philosophy.

It is extremely difficult to evaluate the impact of professional development training on classroom practice because of the large number of mediating variables. InSTEP provides professional development training for a large number of educators while also providing technical and instructional support along with resources and software. Controlling for such mediating variables will allow the current study to investigate the true influence of technical skill, constructivist teaching strategies, attitude toward technology, and constructivist teaching philosophy on constructivist uses of technology.

## Technology and Constructivist Teaching Strategies

An incorrect assumption has developed that providing technology infrastructure (software, hardware, training) would change teachers' practice toward more constructivist methods of teaching (David, 1991; 1994). However, computers have been incorporated into traditional practice more so than into constructivist practice (Niederhauser & Stoddart, 2001). Many efforts to integrate technology with instruction have not been effective because teachers with the proper technical skills tend to use technology in ways that are consistent with their personal beliefs about education (Cuban, 1986). As a result, educational reform efforts that merely increase technology integration fail because of their inability to change the educational beliefs of teachers. However, recent studies (Howard, McGee, Schwartz, & Purcell, 2000; Vannatta & Beyerbach, 2000) have found that technology integration may result from exposure to constructivist teaching strategies with technology used as a supplement to enhance constructivist teaching.

## Constructivist Teaching First, Technology Second

Kanowith-Klein, Burch, and Stevens (1998) found that training teachers to implement an interactive multimedia exercise (IMMEX) into their curriculum was successful only when technology integration was secondary to inquiry training. Moreover, Battista and Borrow (1998) found in an observation of a teacher and a student using spreadsheets to compute algebraic formulas that the use of the spreadsheet was successful only when instruction focused on sense making, not symbol manipulation. These findings are consistent with current research, which suggests that teachers first need a constructivist framework before they can begin to see the benefit of integrating technology into curriculum (Vannatta & Beyerbach, 2000).

Teachers who believe technology integration should be required not only use problem-based learning more frequently, but they also believe that it is motivating to the students and helps the students to build lifelong skills (Kirkwood, 2000). The U.S. Congress (1995) explains that although teachers must change their strategies to integrate technology into curriculum, they find it beneficial because of the richness of student learning. As a product of technology integration, teachers reported they 1) expect more of students, 2) are more comfortable with students working independently, 3) present more complex materials, 4) tailor instruction more to individual needs, 5) adopt new roles ("guide on the side" rather than "sage on the stage"), and 6) spend less time lecturing so that classrooms are more student-centered.

The combination of technical skill and constructivist practice also relates to the development of a constructivist philosophy. Howard, McGee, Schwartz, and Purcell (2000) found that after training a selected group of teachers to use constructivist strategies while providing technology training that teachers developed a more constructivist view of education. Research also shows that the lack of a constructivist philosophy is seen as a barrier to the entire process of training teachers to effectively integrate technology into the classroom (Becker, 2000; Brickner, 1995). In summary, technical skill (Wishart & Blease, 1999; Kirkwood, 2000; Atkins & Vasu, 2000), a constructivist teaching philosophy (Brickner, 1995; Becker, 2000), and a positive attitude toward technology integration (Brickner, 1995) facilitate effective technology integration. The InSTEP™ workshops are designed to directly affect teachers' constructivist teaching strategies and technical skills with the goal of promoting effective technology integration.

## METHOD

### Participants

In the summer of 2001, a total of 257 West Virginia math, science, and technology teachers participated in the Integrating Strategies and Technology in Education Practice workshops at the Center for Educational Technologies® at Wheeling (WV) Jesuit University. Each workshop was five days long and engaged the teachers in intensive training on problem-based learning and the integration of technology. Each teacher was compensated with a $100/day stipend, three graduate credit hours, and a $350 minigrant for the purchase of software or hardware. Teachers who later conducted two professional development workshops (for other teachers) were compensated an additional $300.

### Integrating Strategies and Technology in Education Practice

The InSTEP workshops were designed to enhance teachers' understanding of constructivist learning principles and their ability to integrate technology into the classroom. At the beginning of the week teachers were placed in collaborative groups to work on a scientific problem. Throughout the week, teachers were trained to implement constructivist teaching strategies into a problem-based learning environment while also using technology. Some examples of the technology that teachers were trained to use include Microsoft® Excel, Geometer Sketchpad™, Inspiration™, PowerPoint®, digital cameras, etc. The intensity of the technical training sessions was tailored to the needs of the teachers. At the end of the week, each group of teachers had to give a 10-minute presentation of their solution.

After the rigorous week of training, teachers were then assigned to design a lesson plan for their upcoming class following the same problem-based learning framework. Teachers were required to integrate technology into their instructional design.

Regional technical coordinators were made available to each teacher to provide technical, instructional, and professional support throughout the whole InSTEP™ project. These coordinators were available to help the teachers with their courses and also with the professional development workshops they had to conduct.

### TLC Survey

The original teaching, learning, and computing (TLC) survey (Becker, 2000) is a self-report questionnaire that measures teaching practice, teaching beliefs, technology use in the classroom, and teacher professionalism. The TLC was used in a national survey that assessed 4,100 teachers. The original version was made up of 21 pages that took approximately 60-75 minutes to complete. Four different versions of the survey were used in the national study with some overlapping items. Information about the validity of the survey is provided elsewhere (see Becker & Anderson, 1998).

The current study combined the four versions into one questionnaire. The final TLC questionnaire consisted of 17 pages that took approximately one hour to complete. Five constructs were derived from the TLC for purposes of the evaluation of InSTEP: technical skill (TS), constructivist teaching strategies (CTS), attitude toward technology (ATT), constructivist teaching philosophy (CTP) and constructivist uses of technology (CUT). Survey items were grouped according to these constructs and responses were standardized to generate a participant score for each construct.

Procedure

During the summer of 2001, each teacher completed the TLC survey at the beginning of their InSTEP workshop. At the end of the workshop, the teachers rated the overall quality of the workshop in an online survey. Participants' responses to the online survey questions were then averaged to generate individual InSTEP workshop quality ratings (Q). Finally, in January 2002 teachers were asked to complete the TLC survey again.

Study Hypotheses

The purpose of the evaluation is to determine significant changes in the influence of mediating variables on constructivist uses of technology. See Figure 1 for a diagram of the evaluation framework.

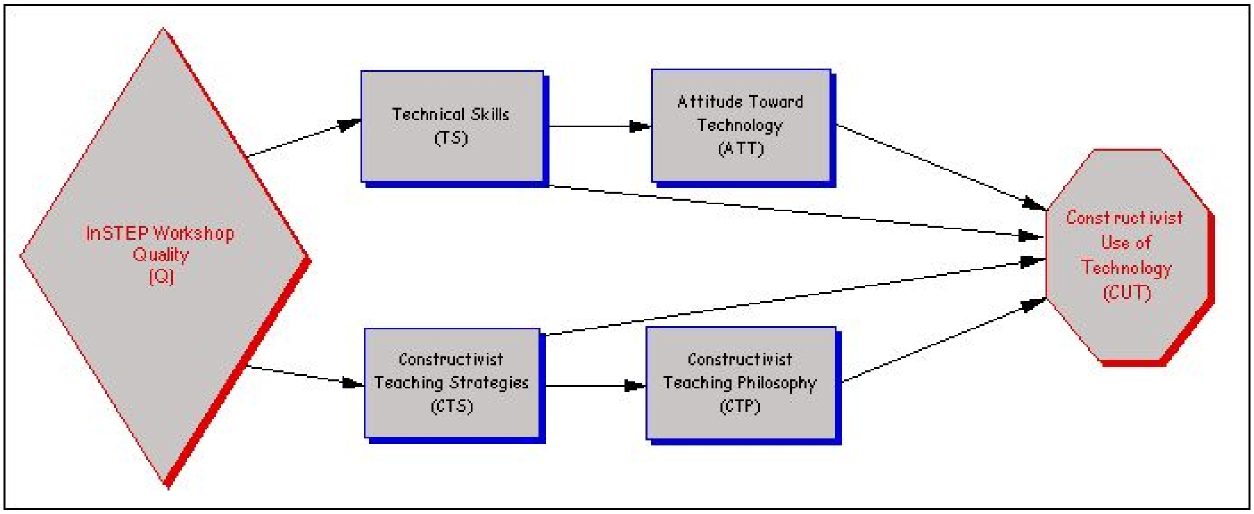


Figure 1: InSTEP™ evaluation framework

Based on our evaluation framework (see Figure 1), we propose two main hypotheses.

1. It is hypothesized that the scores on the five constructs (TS, CTS, CTP, ATT, and CUT) will significantly increase after teachers participate in the InSTEP workshop.
2. It is hypothesized that significant relationships will be found between the constructs as specified in the framework (see Figure 1). Of particular interest is how the relationships between these variables change as a function of InSTEP. Technical skill and constructivist teaching strategies are the focus of InSTEP training. We anticipate that these constructs will be stronger predictors of constructivist uses of technology as a result of the workshop.

## RESULTS

The pre- and post workshop means and standard deviations for each evaluation construct are reported in Table 1. Note that the construct scores are not comparable to one another. The only valid comparison is pre-to-post administration.

To test hypothesis 1, we conducted five paired-sample t-tests on the means of each evaluation construct. Results show that scores on all constructs significantly increased after teachers' participation in the InSTEP™ workshop. Table 1 also shows the paired t-test results for each construct.

Table 1: Pre/Post Means, Standard Deviations, and t-Test Results for Evaluation Constructs

| Construct | | M | SD | t | df | p |
|---|---|---|---|---|---|---|
| **TS** | pre | .406 | .186 | 9.68 | 136 | < .001 |
| | post | .504 | .165 | | | |
| **CTS** | pre | .482 | .148 | 2.11 | 132 | .019 |
| | post | .512 | .171 | | | |
| **ATT** | pre | .673 | .188 | 7.90 | 136 | < .001 |
| | post | .755 | .162 | | | |
| **CTP** | pre | .620 | .112 | 2.36 | 135 | .010 |
| | post | .644 | .128 | | | |
| **CUT** | pre | .444 | .248 | 3.75 | 113 | < .001 |
| | post | .510 | .230 | | | |

To test hypothesis 2, we carried out a series of multiple regressions corresponding to our evaluation framework (see Figure 1). Table 2 shows the regression coefficients, significance levels, and standard errors of the predictors at pretest. Figure 2 displays the results in the context of our evaluation framework. Table A1 in the appendix lists the pre-InSTEP correlations between constructs.

Table 2. Pretest Path Analysis Results.

| | Dependent variables [a] | | |
|---|---|---|---|
| Predictors | Attitude toward technology (ATT) | Constructivist teaching philosophy (CTP) | Constructivist uses of technology (CUT) |
| Technical skill (TS) | .71***<br>.72<br>(.06) | | .27**<br>.36<br>(.14) |
| Constructivist teaching strategies (CTS) | | .46***<br>.35<br>(.06) | .16<br>.26<br>(.13) |
| Attitude toward technology (ATT) | | | .38**<br>.51<br>(.14) |
| Constructivist teaching philosophy (CTP) | | | -.02<br>-.05<br>(.17) |
| $R^2$ (percentage) | 51.0 | 21.2 | 43.5 |

[a] For each dependent variable, standardized regression coefficient (β) is shown on the first line; unstandardized regression coefficient (b) is shown on the second line; standard error (in parentheses) is shown on the third line.

*p < .05, **p < .01, ***p < .001.

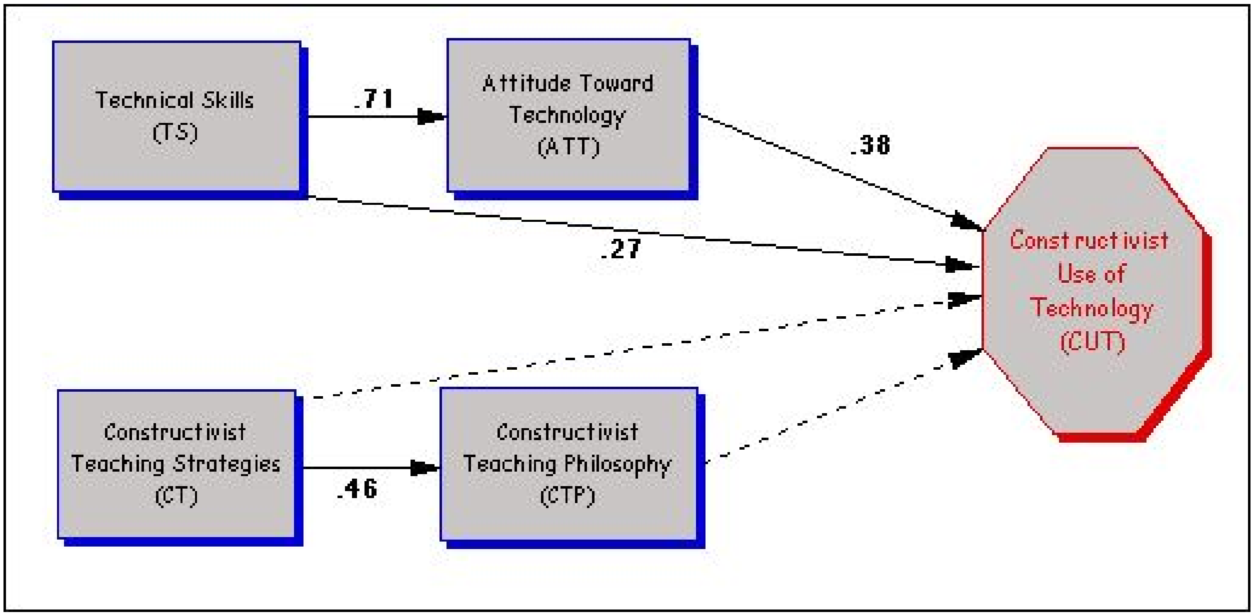


Figure 2. Pretest path analysis results. (Dashed lines indicate path coefficients were not significant.)

We found that technical skills were significantly related to attitude toward technology, and constructivist teaching strategies were significantly related to constructivist teaching philosophy. Furthermore, technical skill and attitude toward technology were significantly related to constructivist uses of technology. Neither constructivist teaching strategies nor constructivist teaching philosophy were significantly related to constructivist uses of technology before the InSTEP™ workshop. The four constructs together accounted for 43.5 percent of the variance for constructivist uses of technology.

Table 3 shows the regression coefficients, significance levels, and standard errors of the predictors at posttest (after the InSTEP workshop). Figure 3 displays the results in the context of our evaluation framework. Table A2 in the appendix lists the post-InSTEP correlations between constructs.

We found that InSTEP workshop quality was significantly related to both technical skill and constructivist teaching strategies (which were the focus of the workshop training). As we hypothesized, these constructs were stronger predictors of constructivist uses of technology after the workshop. And, as was the case in the pretest, constructivist teaching philosophy was not significantly related to constructivist uses of technology. After teachers' participation in the InSTEP workshop, the four constructs together accounted for 50.2 percent of the variance for constructivist uses of technology. See Table 3 for details of posttest path analysis.

Table 3. Posttest Path Analysis Results

| | Dependent variables [a] | | | | |
|---|---|---|---|---|---|
| Predictors | Technical skill (TS) | Constructivist teaching strategies (CTS) | Attitude toward technology (ATT) | Constructivist teaching philosophy (CTP) | Constructivist uses of technology (CUT) |
| InSTEP™ workshop quality (Q) | .25**<br>.08<br>(.03) | .26**<br>.09<br>(.03) | | | |
| Technical skill (TS) | | | .67***<br>.66<br>(.06) | | .38***<br>.53<br>(.13) |
| Constructivist teaching strategies (CTS) | | | | .40***<br>.29<br>(.06) | .16*<br>.20<br>(.10) |
| Attitude toward technology (ATT) | | | | | .33***<br>.46<br>(.12) |
| Constructivist teaching philosophy (CTP) | | | | | -.10<br>-.17<br>(.12) |
| $R^2$ (percentage) | 6.2 | 7.0 | 44.8 | 15.6 | 50.2 |

[a] For each dependent variable, standardized regression coefficient (β) is shown on the first line; unstandardized regression coefficient (b) is shown on the second line; standard error (in parentheses) is shown on the third line. *p < .05, **p < .01, ***p < .001.

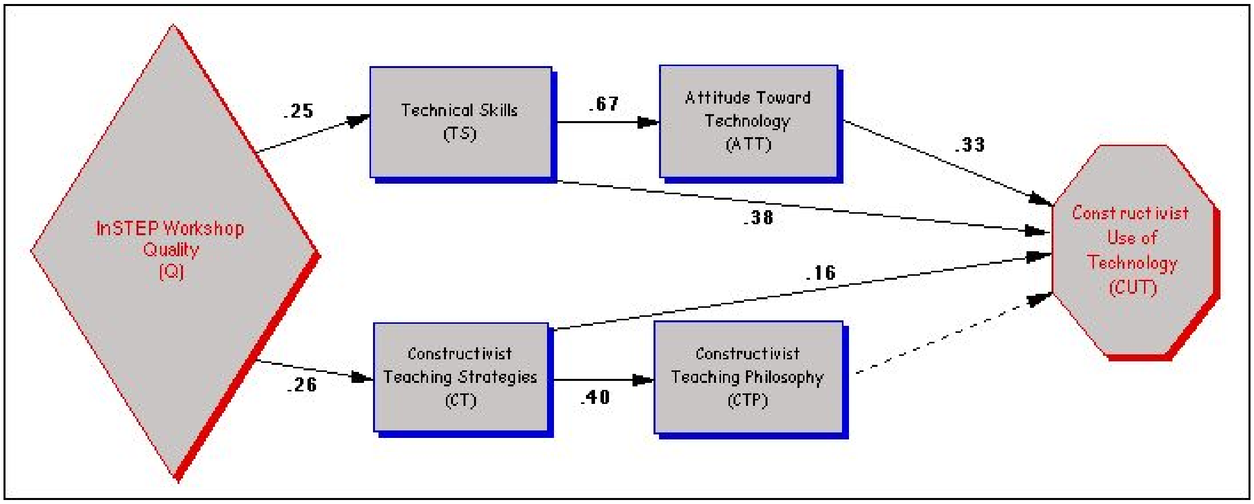


Figure 3. Posttest path analysis results. (Dashed lines indicate path coefficients were not significant.)

Before the InSTEP™ workshop constructivist teaching strategies were not significantly related to constructivist uses of technology. Therefore, those teachers that were using constructivism as a base for technology integration had technical skill but did not make use of constructivist strategies. One can conclude from this that constructivist uses of technology were being implemented without a proper constructivist teaching framework. However, after InSTEP participants completed the workshop, constructivist teaching strategies were significantly related to constructivist uses of technology. InSTEP successfully gave teachers a constructivist framework for the implementation of technology in which they not only improved upon, but also carried out in the classroom.

## DISCUSSION

Larry Cuban (1986) made a claim that technology in the K-12 classroom had little impact on education reform efforts and that the impact of technology was unlikely to change in the future. This finding led many researchers to search for the factors that made technology influential. Careful investigation revealed the following factors as being responsible for successful technology integration: constructivist philosophy (Becker & Ravitz, 2001), technical skill (Atkins & Vasu, 2000; Becker & Ravitz, 2001), a positive attitude toward technology (Kirkwood, 2000), and ongoing adequate support (Ertmer & Hruskocy, 1999; Atkins & Vasu).

Becker and Ravitz (2001) reported that while a constructivist philosophy is crucial to successful technology integration, one is very unlikely to change one's educational philosophy. However, Howard, McGee, Schwartz, and Purcell (2000) found that after training a selected group of teachers to use constructivist strategies while providing technology training, teachers developed a more constructivist view of education. Though these results are supported by the current study, our results show that the philosophy of constructivism is not related to constructivist uses of technology. Rather, it is a product of using constructivist teaching strategies, which is a significant predictor of constructivist uses of technology. Thus, professional development must change its focus to target constructivist teaching strategies rather than the educational philosophy of educators.

The current study also supports the finding that technology training must be done along with or as a supplement to constructive teaching methods in order for successful technology integration within a constructivist framework to occur (Kanowith-Klein, Burch, & Stevens, 1998; Battista, & Borrow, 1998). InSTEP™ is a unique approach because it trains constructivist teaching strategies and technical skill simultaneously. By training on these key predictors, the philosophy of constructivist teaching and a positive attitude toward technology will emerge, leading to the accounting of 50 percent of the variance for constructivist uses of technology. Another reason for the success of InSTEP was successful control of barriers by providing ongoing training and support along with money for educational software. Ertmer and Hruskocy (1999) explain the importance of integrating a support system that is necessary for the initiation and maintenance of technology implementation.

The current trend in the success of technology integration in the classroom is dependent on the way in which technology is integrated into educational curriculum. This evaluation of Integrating Strategies and Technology into Educational Practice gives insight into the factors that relate to constructivist uses of technology. The evaluation specifically informs us that technical skill and constructivist teaching strategies must be influenced directly through professional development efforts. It is important to note that a positive attitude toward technology was an indirect influence of the workshop. More importantly, the evaluation of InSTEP provides promise for the future of professional development and suggests that technology can reform education efforts now and in the future.

## APPENDIX

Table A1. Correlations Among Variables (Pre-InSTEP™)

| | TS | CTS | ATT | CTP | CUT |
|---|---|---|---|---|---|
| TS | 1.00 | | | | |
| CTS | .23* | 1.00 | | | |
| ATT | .71* | .32* | 1.00 | | |
| CTP | .13 | .46* | .26* | 1.00 | |
| CUT | .58* | .32* | .63* | .19* | 1.00 |

Note: Pairwise correlations are based on *n* values ranging from 120 to 137. *p<.05

Table A2. Correlations Among Variables (Post-InSTEP™)

| | TS | CTS | ATT | CTP | CUT | Q |
|---|---|---|---|---|---|---|
| TS | 1.00 | | | | | |
| CTS | .32* | 1.00 | | | | |
| ATT | .67* | .34* | 1.00 | | | |
| CTP | .18* | .40* | .20* | 1.00 | | |
| CUT | .64* | .36* | .63* | .12 | 1.00 | |
| Q | .17* | .19* | .22* | .06 | .15 | 1.00 |

Note: Pairwise correlations are based on *n* values ranging from 120 to 137. *p<.05

REFERENCES


Atkins, N. E., & Vasu, E. S. (2000). Measuring knowledge of technology usage and stages of concern about computing: A study of middle school teachers. *Journal of Technology and Teacher Education, 8*(4), 279-302.

Battista, M. T., & Borrow, C. V. (1998, April). Using spreadsheets to promote algebraic thinking. *National Council of Teachers of Mathematics,* 470-478.

Becker, H. J. (2000). *Findings from the teaching, learning, and computing survey: Is Larry Cuban right?* Paper presented at the School Technology Leadership Conference of the Council of Chief State School Officers, Washington, D.C.

Becker, H. J., & Anderson, R. E. (1998). *Validating self-report measures of the constructivism of techers' beliefs and practices*. Paper presented at the American Educational Research Association, San Diego.

Becker, H. J., & Ravitz, J. L. (2001). *Computer use by teachers: Are Cuban's predictions correct?* Paper presented at the American Educational Research Association, Seattle.

Becker, H. J., & Riel, M. M. (1999). *Teacher professionalism and the emergence of constructivist-compatible pedagogies*. Paper presented at the American Educational Research Association, Montreal.

Brickner, D. (1995). *The effects of first- and second-order barriers to change on the degree and nature of computer usage of secondary mathematics teachers: A case study*. Unpublished doctoral dissertation, Purdue University, West Lafayette, IN.

Cole, S. L. (2000). Technology has found its way into our schools–Now what? *TechTrends, 44*(6), 23-27.

Cuban, L. (1986). *Teachers and machines*. New York: Teachers College Press.

David, J. (1991). Restructuring and technology: Partners in change. *Phi Delta Kappan, 73*, 37-40.

David, J. (1994). Realizing the promise of technology: A policy perspective. In B. Means (Ed.), *Technology and education reform* (pp. 169-190). San Francisco: Jossey-Bass.

Dwyer, D. C., Ringstaff, C., & Sandholtz, J. H. (1991). Changes in teachers' beliefs and practices in technology rich classrooms. *Educational Leadership, 48*(8), 45-52.

Ertmer, P. A., & Hruskocy, C. (1999). Impacts of a university-elementary school partnership designed to support technology integration. *Educational Technology Research and Development, 47,* 81-96.

Hooper, S., & Rieber, L. (1995). Teaching with technology. In A.C. Orstein (Ed.). *Theory into practice* (pp. 155-170). Boston: Allyn and Bacon.

Howard, B. C., McGee, S., Schwartz, N., & Purcell, S. (2000). The experience of constructivism: Transforming teacher epistemology. *Journal of Research on Computing in Education*, *32*(4), 455-465.

Kanowith-Klein, S., Burch, C., & Stevens, R. H. (1998, Summer). Sleuthing for science. *Journal of Staff Development*, 48-53.

Kirkwood, J. J. (2000). The status of technology education in elementary schools as reported by beginning teachers. *Journal of Industrial Teacher Education, 37*(3), 1-15.

Niederhauser, D. S., & Stoddart, T. (2001). Teachers' instructional perspectives and use of educational software. *Teaching and Teacher Education, 17,* 15-31.

U.S. Congress, Office of Technology Assessment, *Teachers and technology: Making the connection*, OTA-HER-616 (Washington, DC: U.S. Government Printing Office, April 1995).

Vannatta, R. A., & Beyerbach, B. (2000). Facilitating a constructivist vision of technology integration among education faculty and preservice teachers. *Journal of Research on Computing in Education, 33*(2), 132-148.

Wishart, J., & Blease, D. (1999). Theories underlying perceived changes in teaching and learning after installing a computer network in a secondary school. *British Journal of Educational Technology, 30*, 25-41.