Effectiveness of Integrating Strategies and Technology in Education Practice (InSTEP™) on Constructivist Uses of Technology

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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% of training) and software (30%) but not on how to integrate these tools into educational curriculum (15%) (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 constructivist uses of technology because of the large number of mediating variables. Technical skill, attitude toward technology, constructivist teaching strategies, and constructivist teaching philosophy all influence constructivist uses of technology. 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 impact of InSTEP on teaching practice.

Integrating Strategies and Technology in Education Practice

The purpose of InSTEP™ is to provide teachers with constructivist teaching strategies and methods for integrating a variety of technical software into educational curriculum. InSTEP is a multiyear project funded by the U.S. Department of Education, focusing primarily on West Virginia teachers. At this writing, the InSTEP project is in its second year of funding.

InSTEP workshop participants receive five days of intensive training in problem-based/inquiry learning and the effective integration of technology into the teaching and learning process. Each workshop day consists of a variety of continuous and concurrent sessions focusing on four areas: problem-based/inquiry learning (PBL), instructional design, technology, and hands-on activities.

Problem-Based/Inquiry Learning - As members of a problem-solving team, participants work together to research an environmental problem and develop, present, and defend their solution to their peers. Teachers use the Exploring the Environment® web site as a model of problem-based learning. They interact with a team of real students who are working on a similar problem and have the opportunity to hear about student personal growth, see student achievement, and share in student success. This mirroring of the problem-based learning process provides participants the opportunity to acquire firsthand experience from both the student and teacher perspectives.

Instructional Design - Participants analyze the components of sound instructional design and actively participate in a variety of cooperative and collaborative learning strategies. Participants develop their own standards-based instructional design incorporating best practices into the implementation. They identify alternative assessments and incorporate technology into a design that will turn their classroom into a training center for lifelong learners.

Technology Tools, Skills, and Applications - Participants receive training in the use of a variety of productivity and technology tools. All training is conducted within the context of teaching content, making the training meaningful and promoting technology usage.

Hands-On Activities - The hands-on activities model a constructivist approach that addresses a variety of learning styles and intelligences. Participants see how the simplest of activities can be adapted to challenge students to develop probing questions and to search for solutions.

Teachers receive an $80/day stipend, travel expenses, the option of gaining three graduate credit hours, and the choice of a technology tool (Casio digital camera, Palm™ m130, Inspiration®, The Geometer's Sketchpad®, Kidspiration®). Teachers who later conduct two professional development workshops in their region earn an additional $300.

Regional technical coordinators are available to provide technical, instructional, and professional support throughout the whole InSTEP project. These coordinators can help teachers with their courses and also with the professional development workshops they have to conduct.

InSTEP Sequence

The phases of InSTEP are based on the Academy of Problem-Based Learning Studies at the Center for Educational Technologies®. The academy provides theory, modeling, practice, and feedback in problem-based learning instructional design and implementation techniques for teachers from grade school through graduate school. Based upon the works of Bob Myers, Hilarie Davis, and Jim Botti, the academy offers the following PBL certifications: instructor, author/designer, advanced author/designer, and trainer. See Appendix A for a description of the academy.

InSTEP offers four levels of professional development: Step I is for new participants. Participants then progress through Step II, Step II+, and Step III over subsequent summers.

Step I workshops focus on the skills and strategies needed to create student-centered classrooms through the use of inquiry, cooperative learning, hands-on experience, and the effective incorporation of technology. Teachers begin building the skills and experience needed to qualify as a problem-based learning instructor. Requirements include designing and implementing a problem-based/inquiry instructional design and facilitating two professional development workshops for other teachers in their region.

Step II workshops focus on the skills and strategies needed to create student-centered classrooms through the use of problem-based learning scenarios, alternative assessment tools, and effective incorporation of technology. Building on Step I experience, teachers acquire and apply the additional skills needed to qualify as a problem-based learning author/designer. Requirements include creating a problem-based learning scenario, designing an authentic assessment tool, developing an instructional design using the scenario and assessment tool. Participants are also required to facilitate two professional development workshops for other teachers in their region.

Step II+ workshops focus on the skills and strategies needed to develop web pages with instructional designs for teachers to create student-centered classrooms through the use of problem-based learning scenarios, alternative assessment tools, and effective incorporation of technology. Building on Step I and Step II experiences, teachers acquire and apply the additional skills needed to qualify as a problem-based learning advanced author/designer. Requirements include transferring their instructional design in an html format, completing peer reviews of fellow Step II+ participants' instructional designs. Participants are also required to facilitate one professional development workshop for other teachers in their region showcasing their instructional design.

Step III workshops focus on the practice and refinement of technology and instructional skills and strategies. Teachers motivate others to adopt a problem-based learning approach. Building on their InSTEP experience, teachers acquire and practice the additional skills needed to qualify as a problem-based learning trainer. Requirements include serving as a mentor for Step II and Step II+ participants during the workshop. Step III participants also must create the student view of their problem-based learning instructional design in an html format.

Teachers maintain a portfolio throughout the InSTEP process. At the end teachers submit their completed portfolio for certification. Completion of the workshop sequence does not automatically provide certification. Rather, the quality of their portfolio certifies them at an appropriate level.

METHOD

InSTEP is finishing its second year. There have been two cohorts that have started the process. Cohort A started in 2001 and is finishing its second year. Cohort B started in 2002.

Participants

Cohort A—Starting in the summer of 2001, 244 participants completed Step I. In summer 2002, 71 teachers returned for Step II training (29% return rate). Demographics for the 71 teachers include 86% female, 14% male. The ethnic breakdown includes 1% black, 1% Asian, and 98% Caucasian. Participants teach grades K-4 (39%), grades 5-8 (27%), and grades 9-12 (29%). Teachers in this cohort came in with a lot of classroom experience: 64% have been teaching for more than 10 years, while only 36% have been teaching for 10 years or less.

Cohort B—In summer 2002, 247 West Virginia math, science, and technology teachers participated in Step I training. Demographics of the participants are 85% female and 15% male. The ethnic breakdown is 4% black and 96% Caucasian. The majority of the participants teach elementary (37%) or middle school (40%), with the remaining teaching high school (23%). As with cohort A, these teachers came to the workshop with a lot of classroom experience: 62% have been teaching for more than 10 years, while only 38% have been teaching for 10 years of less.

TLC Survey

The Teaching, Learning, and Computing (TLC) Teacher's 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, 850 principals, and 800 technology coordinators. The original teacher's 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 teacher versions into one questionnaire, keeping only the questions related to the five constructs relevant to the program. The final TLC teacher questionnaire consists of 17 pages taking approximately one hour to complete. In 2003 an online version of the TLC was created.

The five constructs derived from the TLC for the evaluation of InSTEP are 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.

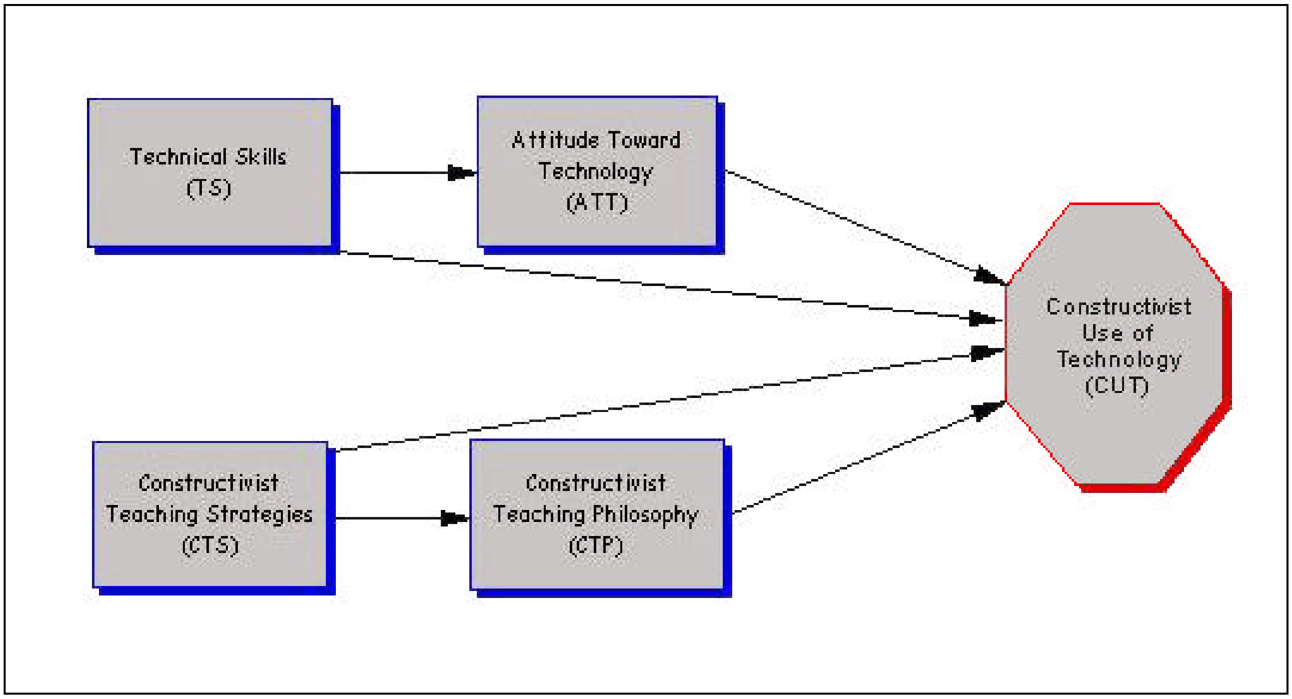
Procedure

Cohort A¾ During summer 2002 teachers completed the TLC survey on the first day of their InSTEP workshop. This is the third administration (28% returned all three) of the TLC to this cohort (see Table 1); see Schmidt, McGee, Scott, Kirby, Norris, and Blaney (2002) for a discussion of the first two administrations.

Cohort B¾ During summer 2002 teachers completed the TLC survey on the first day of their InSTEP workshop. During winter 2003 all participants were sent an e-mail requesting them to complete the online version of the TLC. After the initial deadline passed, the remaining participants were e-mailed again, requesting their completion of the survey (46% return rate).

Table 1. Participation Structure and Evaluation Instrument Administrations

	Pre-Step I	Midyear Step I	Post-Step I



Cohort A	June – Aug. 2001 – TLC	Jan. – Feb. 2002 – TLC	June – Aug. 2002 – TLC
Cohort B	June – Aug. 2002 – TLC	Jan. – Feb. 2003 – TLC	

RESULTS

Evaluation Hypotheses

The purpose of the evaluation is to determine whether the InSTEP program helped teachers more effectively use technology in constructivist ways. InSTEP provides training on technical skill and constructivist teaching strategies. What effect do these and other mediating variables have on constructivist uses of technology? Figure 1 shows a theoretical model for how InSTEP will influence constructivist uses of technology.

Figure 1. InSTEP evaluation framework

Based on the evaluation framework, we propose three hypotheses:

1. It is hypothesized that the five evaluation construct scores collected from cohort A will continue to increase as seen in Schmidt et al. (2002).
2. It is hypothesized that we can replicate the findings from Schmidt et al. (2002) using a new cohort of teachers; the five evaluation construct scores collected from cohort B will significantly increase from pre-Step I to midyear Step I.
3. It is hypothesized that significant relationships will be found between the constructs as shown in the framework (see Figure 1). Using data collected from cohort B, we anticipate that mediating variable constructs will be influenced by InSTEP and that in turn will influence constructivist uses of technology at midyear Step I.

Representativeness of Sample

Those who returned the questionnaire are a sample of the original set. In this analysis we compare the pre-Step I constructs between those who completed the midyear Step I and those who did not. Results show that there were no statistically significant differences for cohort A. However, there were statistically significant difference in cohort B. Cohort B showed difference in technical skill and attitude toward technology, with those responding at the midyear point having higher technical skill and a more positive attitude toward technology. It appears that there is a self-selection bias where those with higher technical skill were able to complete the online version.

Hypothesis 1

To test hypothesis 1, five paired-sample t-tests on the means of each evaluation construct were conducted using the data from cohort A. Table 2 shows the means for each construct. Standard deviations are given in parentheses. As reported in Schmidt et al. (2002) all constructs were statistically significant from pre Step I to midyear Step I. There were also statistically significant differences between the pre- and post-Step I administrations in three of the five constructs: technical skills ($t(68) = 6.53$, $p < .001$), attitude toward technology ($t(68) = 4.07$, $p < .001$), and constructivist teaching strategies ($t(66) = 2.25$, $p = .028$). However, constructivist teaching philosophy ($t(68) = 1.97$, $p = .053$) and constructivist uses of technology ($t(57) = 1.74$, $p = .087$) showed no statistically significant differences. Results show that there were no statistically significant increases on any construct from the midyear Step I to the post-Step I administrations.

Table 2. Cohort A Means and Standard Deviations for Evaluation Constructs (scale 1 low to 5 high)

	Pre-Step I	Midyear Step I	Post-Step I
Constructivist Uses of Technology	2.78 (.93)	2.99 (.93)	2.99 (.94)
Constructivist Teaching Strategies	2.74 (.56)	2.85 (.52)	2.90 (.61)
Constructivist Teaching Philosophy	3.47 (.48)	3.63 (.47)	3.58 (.53)
Technical Skills	2.69 (.60)	3.02 (.54)	3.01 (.53)
Attitude Toward Technology	3.78 (.60)	4.05 (.52)	4.01 (.54)

Hypothesis 2

To test hypothesis 2, five paired-sample t-tests on the means of each evaluation construct were conducted using the data from cohort B. Results show that constructivist uses of technology ($t(105) = 7.75$, $p < .001$), technical skills ($t(112) = 7.56$, $p < .001$), and attitude toward technology ($t(111) = 3.62$, $p < .001$) had statistically significant increases from pre-Step I to midyear Step I. Constructivist teaching philosophy ($t(112) = 1.05$, $p = .3$) and constructivist teaching strategies ($t(111) = 1.68$, $p = .10$) failed to show significant increases. Table 3 shows the means for each construct. Standard deviations are given in parentheses.

Table 3. Cohort B Means and Standard Deviations for Evaluation Constructs (scale 1 low to 5 high)

	Pre-Step I	Midyear Step I
Constructivist Uses of Technology	2.87 (.82)	3.40 (.77)
Constructivist Teaching Strategies	2.81 (.56)	2.88 (.60)
Constructivist Teaching Philosophy	3.59 (.43)	3.63 (.49)
Technical Skills	2.92 (.59)	3.17 (.46)
Attitude Toward Technology	3.96 (.51)	4.09 (.51)

Hypothesis 3

To test hypothesis 3, we carried out a series of multiple regressions corresponding to our evaluation framework (see Figure 1).

Figure 2 displays the midyear Step I standard regression coefficients in the context of the evaluation framework. Table B1 in the appendix lists the midyear Step I correlations. Table B2 shows the regression coefficients, significance levels, and standard errors of the predictors at the midyear Step I time point.

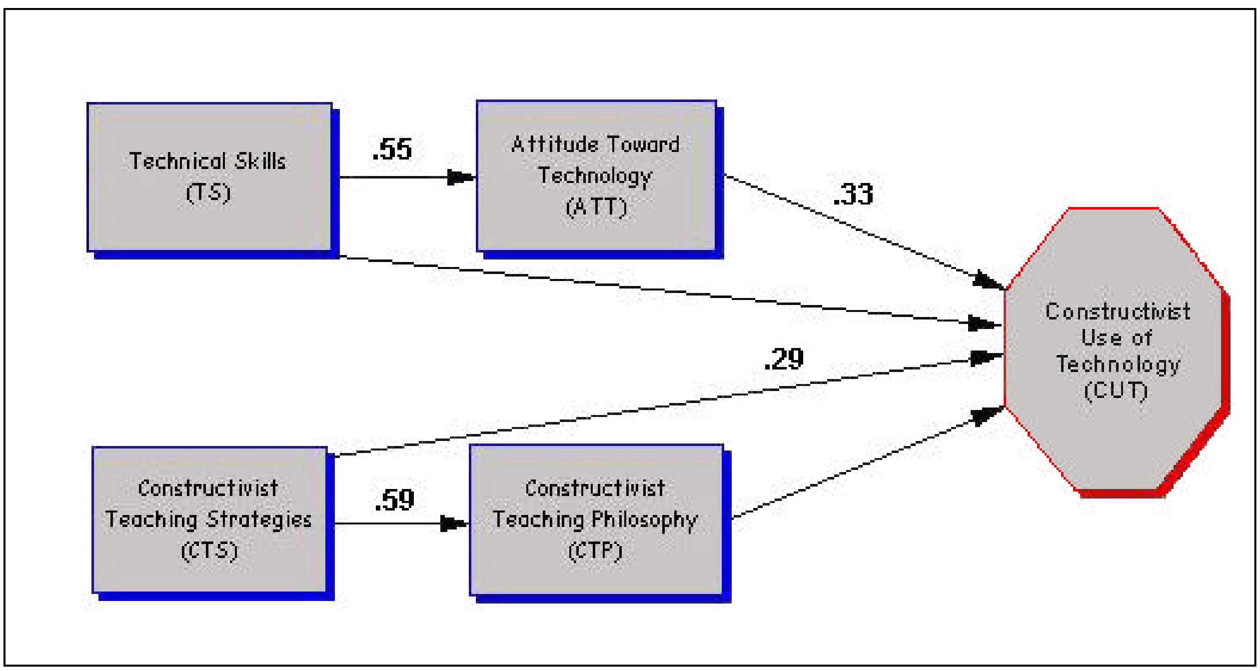


Figure 2. Standardized regression coefficients at midyear Step I

As hypothesized, these constructs were stronger predictors of constructivist uses of technology after the workshop. After teachers' participation in the InSTEP workshop, the four constructs together accounted for 40.4% of the variance for constructivist uses of technology.

DISCUSSION

Hypothesis 1

Cohort A increased from pre-Step I to midyear Step I, but not from midyear Step I to post Step I. There seems to be a leveling effect, which is reasonable given that deliverables were completed in the fall. It is expected that they will increase in the next step.

Hypothesis 2

Cohort B increased from pre-Step I to midyear Step I on their constructivist uses of technology. Participants' attitudes toward technology and technical skill also increased. Contrary to cohort A, constructivist teaching strategies and constructivist teaching philosophy failed to show statistically significant increases. We are not sure why there was not a significant increase in strategies and philosophy. This may be an artifact of the midyear Step I respondents not being a representative sample of cohort B as a whole.

Hypothesis 3

InSTEP workshops focus on improving constructivist teaching strategies and technical skills. If those constructs improve, it is expected that they in turn will positively influence constructivist uses of technology. Results show that attitude toward technology and constructivist teaching strategies had a direct effect on constructivist uses of technology. Constructivist teaching strategies is a significant predictor of both constructivist uses of technology and constructivist teaching philosophy. Meanwhile, technical skills were not a direct predictor of constructivist uses of technology but were an indirect predictor through attitude toward technology. This is different from the results for cohort A at its midyear Step I point. For cohort A technical skills had a direct influence on constructivist uses of technology. Constructivist teaching philosophy was not a direct predictor of constructivist uses of technology.

Overall, the results seem promising. It is anticipated that as the cohort B participants continue in the program, their constructivist teaching strategies should improve. As the model shows, that would lead to even greater constructivist uses of technology. This study is consistent with other reports on professional development literature that recommend teachers sustained their professional development over a long period of time. InSTEP evaluators will continue to monitor the participants over the life of the program.

APPENDIX A

Skills	**PBL Instructor**	**PBL Author/Designer**	**PBL Advanced Author/Designer**	**PBL Trainer**
Problem-Based Learning	Understands basics.	Understands theory and basics.	Understands theory and basics compared with projects and cases.	Understands key concepts, theory, and cognitive psychology.
Implementation Mentors/Tutors	Uses scaffolding for problem posing, questioning, research, and discussion.	Describes scaffolding and coaching for problem posing, questioning, research, and discussion.	Describes implementation alternatives and organizes resources for problem-solving process.	Identifies obstacles and alternatives for effective implementation.
Cooperative Learning	Uses cooperative groups with individual accountability.	Plans for and uses cooperative groups with individual accountability.	Plans for and uses different kinds of cooperative groups with individual accountability.	Applies knowledge-building principles to teaching cooperative learning.
Assessment	Grades using alternative means.	Grades using alternative means.	Develops rubrics.	Develops alternative assessments.
Concept Development		Identifies key concepts of course/curriculum and relevance to students.	Identifies key concepts of course/curriculum and relevance to students.	Has tools for identifying key concepts of course/curriculum and relevance.
PBL Scenario Design		Designs PBL scenarios.	Designs PBL scenarios.	Guides and assesses design of PBL scenarios.
Course Design			Lays out course design and develops modules.	Guides course development.
Field Testing			Conducts action research on student work from own courses.	Conducts action research on student work from own courses.
Author Training				Leads a PBL author workshop and reflects on the results by analyzing participants' products.
Implementation Training				Leads a PBL instructor workshop and reflects on the results through action research on the participants' implementation.

APPENDIX B

Table B1. Cohort B Correlations Among Variables at Midyear Step I

	CUT	CTS	CTP	TS	ATT
CUT	1.00				
CTS	.48**	1.00			
CTP	.34**	.59**	1.00		
TS	.44**	.29**	.12	1.00	
ATT	.55**	.42**	.41**	.55**	1.00

Note: Pairwise correlations are based on *n* values ranging from 112 to 113.
*p<.05, **p<.01
CUT = Constructivist Uses of Technology; CTS = Constructivist Teaching Strategies; CTP = Constructivist Teaching Philosophy; TS = Technical Skills; ATT = Attitude Toward Technology.

Table B2. Cohort B Path Analysis Results at Midyear Step I

	Dependent Variables [a]				
Predictors	TS	CTS	ATT	CTP	CUT
TS			.554*** .609 (.087)		.163 .283 (.162)
CTS				.588*** .476 (.062)	.286** .388 (.129)
ATT					.332** .553 (.164)
CTP					.038 .064 (.159)
R^2	0.0%	3.6%	30.7%	34.6%	40.4%

[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.
CUT = Constructivist Uses of Technology; CTS = Constructivist Teaching Strategies; CTP = Constructivist Teaching Philosophy; TS = Technical Skills; ATT = Attitude Toward Technology.

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