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ABSTRACT

Teaching with Technology (TWT) is a multi-year development program for Idaho teachers, funded and developed by the J.A. and Kathryn Alberston Foundation. TWT is a complement to the Opportunity 1 initiative that made educational technology available to Idaho schools. TWT provides intensive summer training workshops and offers support to teachers during the school year. TWT seeks to: increase teachers' knowledge and skills for working with new technology; and increase teachers' constructivist beliefs about teaching and learning. This report describes TWT's impact on teachers over the course of one academic year. Teachers' responses to a survey administered at three different times (i.e., prior to TWT summer workshops, immediately after the workshops, and ten months after the workshops) were examined. It was concluded that TWT had an impact on a large proportion of participating teachers--teachers reported substantial changes in their technology skills and in their beliefs about good teaching. It was also found that teachers participating in TWT very substantially increased their ability to use computer technology and somewhat shifted their conceptions of good teaching toward constructivism. Appended are: Teaching with Technology Survey, Wave 3; Who Participated in TWT and the Study?; Helpfulness of TWT Technology Fellows and Attitude Changes, by Wave 1 Pedagogical Beliefs and Technology Skills; Training Requests by Grade Level Taught, Changes from Wave 1 to Wave 3; Overall Changes in Constructivist Beliefs, Between Waves, Paired T-test Results; and Overall Changes in Technology Skills, Between Waves, Paired T-test Results. (Contains 10 endnotes, 6 references, and 6 tables.) (MES)

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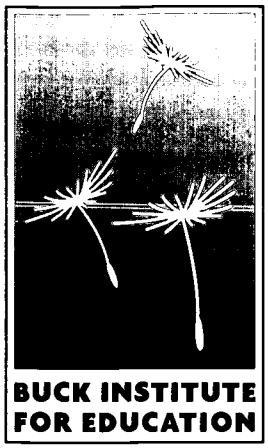

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Evaluation Report

Teaching with Technology: A Statewide Professional Development Program

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October 11, 2002

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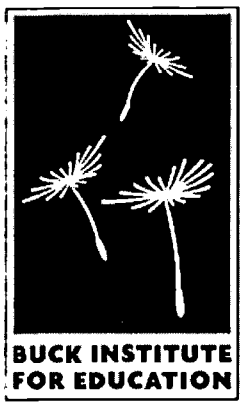

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Executive Summary

Teaching with Technology (TWT) is a multi-year development program for Idaho teachers funded and developed by the J.A. and Kathryn Albertson Foundation. Teaching with Technology is a natural complement to the Opportunity 1 Initiative that made educational technology available to Idaho schools.[1] TWT provides intensive summer training workshops and offers support to teachers during the school year. TWT seeks to:

- increase teachers' *knowledge and skills* for working with new technologies, and
- increase teachers' constructivist *beliefs* about teaching and learning

This report describes TWT's impact on teachers' over the course of one academic year. We examined teachers' responses to a survey administered at three different times:

Wave	Administered ...
1	Prior to TWT summer workshops
2	Immediately after TWT summer workshops
3	End of school year, *10 months after* TWT summer workshops

Our conclusions are based on a comparison of how teachers responded initially to the workshops, and what they indicated 10 months later, i.e., after teaching students in a real classroom for one school year. Survey items about teaching beliefs and technology skills are included in Appendix A.[2]

TWT had an impact on a large proportion of participating teachers. Teachers reported substantial changes in their technology skills and in their beliefs about good teaching. Immediately after the workshop there was a great deal of enthusiasm; many more teachers subscribed to constructivist beliefs than did before participating in the training. After 10 months of day-to-day classroom experience there was slightly less enthusiasm for constructivist pedagogy than there was immediately following the TWT workshop, but a greater proportion of teachers still endorsed constructivist than had before TWT participation.

Teachers participating in TWT very substantially increased their ability to use computer technology and somewhat shifted their conceptions of good teaching toward constructivism. More importantly, in many cases TWT's impact persisted after 10 months of teaching. Indicators of program impact include:

- Reports of the Helpfulness of TWT Technology Fellows and Attitude Changes
- Changes in the Nature of Technology Training Requests Made by Teachers
- Changes in Teachers' Objectives for Computer Use with Students
- Changes in Teachers' Beliefs about Teaching and Learning
- Increases in Teachers' Technology Skills

Each of these success indicators is discussed in the following sections. We also examine which TWT participants reported more positive experiences, and which groups of teachers changed more than other groups.

Reports of the Helpfulness of TWT Technology Fellows and Attitude Changes

Overall response to TWT was very positive among participants in the study.[3] During Wave 3, we asked specifically about the TWT Fellows who had led the workshops and supported teachers during the school year. After 10 months in the classroom 71% of the teachers responding said the TWT Fellows were "extremely helpful" (Table 1); only 5% said the Fellows were "not helpful."

Looking by grade level, Table 1 shows that elementary school teachers reported the most positive experiences, with 76% giving the most favorable responses to questions about the helpfulness of the Technology Fellows. Elementary school teachers also indicated that they had more positive attitudes about technology as a result of TWT. They were followed closely by middle school teachers, and a distant third was high school teachers, where only half responded that the Technology Fellows were extremely helpful (53%) and that they had changed their attitudes (56%) toward technology.

Table 1. Percent of Teachers Reporting Positive Attitude Changes and "Extremely Helpful" Technology Fellows, by Wave 1 Pedagogical Beliefs and Technology Skills

			Type of beliefs		Type of skills	
Grade Level	Response	Percent of teachers	Percent of teachers with less constructivist beliefs	Percent of teachers with more constructivist beliefs	Percent of teachers with less advanced technology skills	Percent of teachers with advanced technology skills
All	Attitude changed?	71%	72%	69%	**83%**	**60%**
	Extremely helpful?	71	73	70	71	72
	N	*110*	*49*	*63*	*52*	*57*
Elem	Attitude changed?	76	72	79	**89**	66
	Extremely helpful?	76	69	**82**	75	77
	N	*63*	*29*	*34*	*28*	*35*
Middle School	Attitude changed?	68	67	69	69	69
	Extremely helpful?	72	**87**	59	63	**86**
	N	*29*	*15*	*16*	*16*	*13/14*
High School	Attitude changed	56	**83**	42	**89**	22
	Extremely helpful	53	**60**	50	**75**	33
	N	17	*6/5**	*12*	*9/8**	*9*

Note: Wave 3 responses only. When there are two Ns the first indicates the number of responses to the "attitude changed" item and the second indicates responses to the "helpfulness" item. Otherwise, the lowest N is shown for each pair of items.

Teachers with less advanced technology skills said their attitudes toward technology changed more often than teachers with advanced technology skills (83% vs. 60%). In high schools, teachers in the *low* belief and *low* technology categories most frequently reported a positive attitude change and that the Technology Fellows were extremely helpful. Among middle school teachers, it was the teachers with higher technology skills (but still those with less constructivist beliefs) who said the Technology Fellows were most helpful. Among elementary school teachers, it was teachers with more constructivist beliefs who said this (82% compared to 69% of the teachers with less constructivist beliefs).

When we combine the technology skills and belief categories into 4 categories (Appendix C) we see that the least positive responses are from those who started out with higher-than-average scores on one measure and lower-than-average scores on the other. Teachers who started with less constructivist beliefs and more technology skills least often changed their attitude toward technology. Of teachers who entered TWT with stronger constructivist beliefs and fewer technology skills, only 58% said the Technology Fellows were extremely helpful.[4]

Table 2 shows that teachers who reported the Technology Fellows were extremely helpful gained more technology skills than teachers who said the Fellows were only somewhat helpful. Those teachers who reported the TWT Fellows were not helpful made considerably less movement toward constructivist pedagogy and technology skills.

Table 2. Standardized Residual Gain Scores for Technology Skills and Constructivist Beliefs[5], by Helpfulness of Technology Fellows

Helpfulness of Technology Fellows	N	Gain in Constructivist Beliefs	S.d.	Gain in Technology Skills	S.d.
Extremely helpful	82	.07	.99	.12*	.93
Somewhat helpful	28	-.01	.79	-.23	1.08
Not helpful	5	-.73	1.66	-.50	1.35
Total	115	.00	1.00	.00	1.00

* $p < .10$, Effect size = .35.

Note. Standardized residual gain scores indicate how much scores were above or below what would have been predicted based on initial Wave 1 responses. A negative gain does not literally mean a loss of skills, but how much less of a gain than the average teacher.

Changes in the Nature of Technology Training Requests Made by Teachers

To see if TWT met teachers' demands for training, we asked at each wave whether teachers wanted additional training on various computer topics. Choices for additional training were: "none"; "start from scratch"; "just a refresher"; and "advanced course."

The percent of teachers requesting training that would "start from scratch" decreased considerably over all three waves, indicating that the desire for initial training in each area was being met. At the same time, requests for "refresher only" and "advanced"

courses went up in several cases. This suggests that after increasing their basic technology skills, teachers still were interested in further training.

Table 3 shows requests for further training concerning "managing students when integrating technology." For this item, the percent of TWT teachers wanting to start from scratch dropped overall and the percent requesting a refresher increased. Appendix D shows how these responses differed by grade level taught.

Table 3. Examples of Additional Training Requests, All Teachers

Additional Training for Managing Students When Integrating Technology	Wave 1 teachers who did NOT answer Wave 3 (N=230)	Wave 1 teachers who DID answer Wave 3 (N=110)	Wave 3 teachers (N=110)	Difference, for those who answered both waves (N=110)
None	5%	4%	13%	9%
Start from scratch	43	39	13	**-26**
Just a refresher	20	20	40	**20**
Advanced course	32	38	35	-3

On most types of training requests, there was a substantial drop in the proportion of teachers requesting "refresher" or "start from scratch" courses. In some cases, there was also an increase in the proportion of teachers saying they desired no further training ("none"). In Wave 3, over half of the teachers for each grade level answered "none" for additional training in word processing, up more than 20% from Wave 1 (Appendix D).

For other types of training, there was a substantial drop in "start from scratch" requests, but an increase in the proportion of teachers wanting "advanced courses." This is seen for teachers in secondary schools, and for these applications.

- Digital imaging
- Integrating technology in daily teaching
- WWW as instructional resource

The most demand for "starting from scratch" during Wave 3 concerned using databases (more than 20% for all grade levels), spreadsheets (24% of high school teachers) and creating multimedia (22% of high school teachers).

From Wave 1 to Wave 3, elementary school teachers generally moved to requesting no additional training while secondary teachers generally moved to wanting advanced courses. For example, among teachers in high schools, there was a gain of 13% requesting advanced courses in spreadsheets, while for elementary school teachers the change was towards wanting no additional training.

Changes in Teachers' Objectives for Computer Use with Students

In each Wave of the study, teachers indicated their top 3 objectives for using computers with students (Table 4). There was a substantial decrease in the proportion of teachers

choosing the more "traditional" objectives for student computer use including mastering or remediating skills, becoming better writers, and learning word processing. There was an increase in the percent choosing more constructivist-compatible objectives, particularly presenting information to an audience and working collaboratively.

Table 4. Percent of Teachers Including Each Objective, in Their Top 3

Type of Change	Wave1 %		Wave2 %	Wave3 %
	Teachers who did NOT answer Wave 3 (N=230)	Teachers who DID answer Wave 3 (N=110)	(N=254)	(N=110)
Increase				
Presenting Info to Audience	28%	39%	48%	48%
Work Collaboratively	21	23	47	39
Finding Ideas and Info	68	70	77	75
Analyzing Info	24	15	24	27
Communicating electronically with others	5	5	8	12
Decrease				
Becoming better writers	31	34	22	25
Mastering or remediating skills	42	29	16	22
Word processing skills	30	34	12	17
Little or no change				
Computer skills, other than word processing	47	47	49	44

Interestingly, gains in some of these objectives continued from Wave 2 to 3 (unlike changes in teachers' beliefs about teaching). Analyzing information and communicating electronically were placed among their top three objectives by greater proportions of teachers in each successive wave.[6] For example, 12% more teachers who answered both waves said "analyzing information" was a top objective in Wave 3 than in Wave 1 and 16% more said this about working collaboratively. Presenting information and finding information had almost no decline in importance from Wave 2 to Wave 3. Other objectives reflecting constructivist pedagogy declined slightly from Wave 2 to Wave 3, but still showed an overall increase in importance from Wave 1 to Wave 3 (Table 4).

Changes in Teachers' Beliefs about Teaching and Learning

For teachers participating in TWT, beliefs about teaching and learning changed in a constructivist direction, with the largest jump occurring immediately after the summer workshops. The change in responses on 8 separate belief questions was statistically significant and in a constructivist direction between Wave 1 and Wave 2 (Appendix E). Between Wave 2 and 3 there was considerable movement back in a traditional direction. Participants reported substantially less constructivist beliefs after 10 months of teaching than they did at the end of the summer. In particular, by Wave 3 more teachers were indicating the importance a "quiet classroom" than in Wave 2 (ES=.30, $p < .01$). Still, compared to Wave 1, there were significant changes in a constructivist-compatible direction shown at the end of the year. There were also some constructivist beliefs that were endorsed *more frequently* in Wave 3 than in Wave 2, suggesting their

popularity did not drop but continued to rise. One of these beliefs included the importance of students establishing their own criteria for assessments.

Among teachers in elementary and middle schools, a greater proportion of teachers in Wave 3 endorsed a constructivist approach as opposed to a structured instruction approach. Teachers in elementary schools also more frequently endorsed multiple simultaneous activities in the classroom in Wave 3 than in Wave 1. In general, teachers in elementary schools changed their beliefs more. On the other hand, it was teachers in high schools who changed the most toward believing students should help set the criteria for assessing their work.

Table 5 shows examples of beliefs where there was significant change between Wave1 and Wave 3, by grade level taught. Regardless of grade level taught, teachers less often endorsed instruction based on giving students many easy problems to solve.

Teachers who sustained their initial Wave 2 changes in a constructivist direction were elementary teachers, and teachers of smaller middle schools. Table 6 shows the change in scores between Wave 1 and Wave 3 for different subsets of teachers.

Table 5. Percent of Teacher Favoring Different Pedagogical Beliefs in Wave 1 and Wave 3, by Grade Level

	Elementary School			Middle School			High School			All Grade Levels		
	Wave 1 teachers who did NOT answer Wave 3	Wave 1 teachers who DID answer Wave 3	Wave 3 teachers	Wave 1 teachers who did NOT answer Wave 3	Wave 1 teachers who DID answer Wave 3	Wave 3 teachers	Wave 1 teachers who did NOT answer Wave 3	Wave 1 teachers who DID answer Wave 3	Wave 3 teachers	Wave 1 teachers who did NOT answer Wave 3	Wave 1 teachers who DID answer Wave 3	Wave 3 teachers
N	140	61	61	48	31	31	42	18	18	230	110	110
Students should be given many easy problems to solve	36%	**49%**	**29%**	39%	**53%**	**44%**	36%	**33%**	**22%**	37%	**48%**	**32%**
Multiple simultaneous learning activities	50	**48**	**73**	41	50	58	45	67	72	47	**51**	**69**
Constructivist approach	41	**39**	**70**	**41**	**41**	**75**	60	61	56	44	**43**	**69**
Comfort with constructivist instruction	33	**33**	**52**	27	**32**	**50**	29	**50**	**39**	31	**36**	**50**
Students should set criteria for assessment	81	87	92	81	84	88	74	**78**	**94**	80	85	91

Changes in Teachers' Technology Skills

The chang/es in technology skills reported by teachers were even more substantial than the changes in teaching philosophy. Gains in technology skills were sustained between Wave 2 and Wave 3 better than changes in philosophy (Table 6). From Wave 1 (beginning of year-long TWT program) to Wave 2 (end of one-week summer TWT training) changes in technology skills as indicated on 11 separate questions were statistically significant.

The skills that increased the most during TWT were developing multimedia and creating web pages. There was some decline in these skills between the end of summer TWT training and the end of the school year. Appendix F highlights that while this did occur, all the evidence shows that teachers made substantial gains in skills that persisted after 10 months.

Which TWT Participants Changed the Most?

Table 6 shows the original Wave 1 scores and how responses changed in Wave 3 for different subsets of teachers. It shows a small but statistically significant difference in beliefs (ES =.17, $p < .001$) and a large difference in skills (ES = 1.51, $p < .001$).

Comparing the different grade levels, elementary school teachers started out with relatively low constructivist beliefs but by Wave 3 they had changed more than teachers in secondary schools and responded to items in a more constructivist fashion than teachers in other grade levels. Teachers in smaller middle schools started out with beliefs similar to teachers in larger middle schools, but the teachers in smaller middle schools reported more constructivist beliefs in Wave 3 (their scores averaged 3.67 compared to 3.44 for teachers in larger middle schools). The increase in the constructivist beliefs of teachers in smaller middle schools is shown as an effect size gain of .40, $p < .10$.

Across the different grade levels, teachers who started with less advanced technology skills ended with less constructivist beliefs than those teachers who began with more advanced technology skills, but they changed their beliefs more than those who started with advanced technology skills. The mean score of less technologically skilled teachers on the constructivist belief index in Wave 1 was 3.47 (compared to 3.55 for teachers with more technology skills) but they had an effect size gain of .24, $p < .05$.

Every group of teachers showed major increases in technology skills, even after 10 months of teaching. Teachers in high schools started with more technology skills. While they reported gains in technology skills, these gains were less than those reported by elementary and middle school teachers. By the end of Wave 3, elementary school teachers reported substantially more skills than high school teachers did in Wave 1 (4.09 vs. 3.28), but still slightly less than high school teachers (4.25). Looking by grade level and size, we see teachers in larger schools started with more advanced technology skills, and gained more than teachers in smaller schools.[7]

Table 6. Teachers Who Moved Toward Constructivist Beliefs and Gained Technology Skills, Paired-Sample Statistics

	N	Belief Index (higher score = more constructivist beliefs) Wave 1	Belief Index (higher score = more constructivist beliefs) Wave 3	Effect Size	Technology Skills Index (higher score = greater technology skills) Wave 1	Technology Skills Index (higher score = greater technology skills) Wave 3	Effect Size
ALL Teachers	119	3.45	3.55	.17***	3.16	4.19	1.51***
		.58	.60		.68	.72	
By Grade Level							
Elementary	63	3.42	3.60	0.36***	3.05	4.09	1.66***
S.d.		*0.51*	*0.65*		*0.63*	*0.73*	
Middle school	30	3.33	3.44	0.17	3.22	4.27	1.49***
S.d.		*0.66*	*0.62*		*0.70*	*0.66*	
High school	18	3.56	3.51	-0.07	3.28	4.26	1.18***
S.d.		*0.62*	*0.52*		*0.83*	*0.74*	
By Grade Level and Size							
Middle school, smaller	9	3.41	3.67	0.40*	2.89	4.00	1.42***
S.d.		*0.64*	*0.52*		*0.78*	*0.79*	
Middle school, larger	19	3.44	3.44	0.00	3.41	4.42	1.60***
S.d.		*0.60*	*0.60*		*0.64*	*0.56*	
High school, smaller	7	3.56	3.43	-0.17	2.96	3.83	0.93***
S.d.		*0.73*	*0.60*		*0.93*	*0.73*	
High school, larger	7	3.75	3.72	-0.12	3.66	4.75	2.21***
S.d.		*0.29*	*0.35*		*0.49*	*0.18*	
Within Grade Level Technology Skills Ntiles (Wave 1)							
Lower tech skills	56	3.31	3.47	0.24**	2.60	3.74	2.84***
S.d.		*0.66*	*0.66*		*0.40*	*0.65*	
Higher tech skills	61	3.58	3.65	0.14	3.67	4.59	2.09***
S.d.		*0.48*	*0.54*		*0.44*	*0.50*	
With Grade Level Constructivist Beliefs Ntiles (Wave 1)							
Less constructivist beliefs	49	2.91	3.12	0.58***	2.98	4.03	1.52***
S.d.		*0.38*	*0.49*		*0.69*	*0.81*	
More constructivist beliefs	67	3.84	3.86	0.06	3.29	4.30	1.55***
S.d.		*0.34*	*0.48*		*0.65*	*0.62*	
Starting Out (within grade level, Wave 1) with...							
Less technology skills, Less constructivist beliefs	29	2.80	3.07	0.66***	2.52	3.57	2.89***
S.d.		*0.41*	*0.50*		*0.36*	*0.68*	
Greater technology skills, Less constructivist beliefs	20	3.05	3.24	0.68**	3.65	4.69	2.26***
S.d.		*0.27*	*0.46*		*0.46*	*0.44*	
Less technology skills, More constructivist beliefs	26	3.86	3.90	0.11	2.69	3.92	2.87***
S.d.		*0.37*	*0.53*		*0.43*	*0.58*	
Greater technology skills, More constructivist beliefs	41	3.84	3.85	0.03	3.68	4.54	1.98***
S.d.		*0.31*	*0.46*		*0.44*	*0.53*	

*** p < .0001, ** p < .05, * p < .10

Note. Effect size is based on Wave 1 standard deviations. The maximum score was 5.0 on both indices. The extent of the change is indicated by the effect size, and the statistical significance provides confidence that the result was not caused by chance alone.

Discussion

In our analyses of TWT impact, we have focused on group averages and compared changes that occurred across different types of teachers. This is done to portray what happened to different groups of "average TWT participants." In reality, however, people rarely embody the all the qualities attributed to the average person, and the reader is reminded that it is important not to assume that group averages always describe the pedagogy and technology skills or changes of individual teachers. Undoubtedly, there are some teachers within larger and smaller schools, regardless of grade level, who can provide examples of different types of pedagogical beliefs, technology skills, and changes.

TWT participants who responded to the surveys were enthusiastic about their experiences. End-of-year responses about the helpfulness of the Technology Fellows could not have been much more favorable, and 95% of teachers said their attitude toward technology changed as a result of the TWT program. This proportion is notable given that such a large proportion of teachers already had considerable technology experience (Appendix A).

More important than their initial enthusiasm is the ability of the TWT teachers to sustain that enthusiasm after 10 months in the classroom. ***The comparison between Wave 1 and Wave 3 responses represent the best indication of the change that occurred overall. These analyses provide a very consistent indication that the training program has had a lasting and positive effect.***

Findings comparing Wave 1 and 2 reflect an "enthusiasm effect" so that the changes in belief and skills that were reported immediately after the training were artificially high. Findings comparing Wave 2 and Wave 3, on the other hand, reflect a "reality effect" so that in many cases, not all, the initial changes could not be sustained in the face of the demands presented during the school year. Most notably, teachers by Wave 3 wanted quieter classrooms than they did at the end of the summer, and they were less confident in their skills to create a web page.

Although the goals of TWT were not simply to increase teachers' technology skills, ***it was easier to develop teachers' technology skills than to change their beliefs about teaching and learning, and move them toward a more constructivist pedagogy.*** Teachers in elementary, middle, and high schools all reported gains in technology skills that persisted through the end of the year. In contrast, only teachers in elementary schools and in smaller middle schools reported sustained changes in pedagogical beliefs through Wave 3.[8]

The least change observed – and consequently, the biggest challenge – was in changing the beliefs of teachers in the larger secondary schools. However, there is some evidence of success for TWT even among teachers in these schools. These

different outcomes may be less an issue of program design, and more an issue of organizational capacity.[9] Elementary schools and smaller schools may provide more supportive environments for the implementation of constructivist pedagogy.

There was less of a "reality effect" for technology skills. The skills that "decreased" from Wave 2 to Wave 3 were those that had gained the most initially, and that gained the most in the end -- multimedia and Web page skills. Even though technology skills improved, there was still substantial demand for further training in these areas, especially in secondary schools.

If we had studied "anticipated use" with students (in Wave 2) and "actual use" (in Wave 3) we almost certainly would have seen a bigger reality effect concerning technology. This is because there is a difference between teachers having technology skills and what is required for them to actually use technology with students in the classroom. Given the limits of our evaluation data, we have no way of knowing to what extent gains in teachers' technology skills were associated with substantial changes in the amount or quality of technology use with students.[10]

The only indication of the quality of computer use with students we have concerns the objectives for use that teachers reported. These show an increase in constructivist objectives. The fact that these changes were sustained through Wave 3 is perhaps the best evidence of a real change in the classroom use of educational technology among TWT teachers.

In conclusion, even though they started out more technologically skilled than the average Idaho teacher and more constructivist in philosophy (Appendix A) participants in TWT clearly moved even further in these directions.

ENDNOTES

[1] For Opportunity 1 results see Opportunity 1 (2002) and Ravitz, Mergendoller and Rush (2002).
[2] For more information about these instruments and the studies where they have been used, see the Teaching, Learning & Computing: 1998 project web site -- http://www.crito.uci.edu/TLC
[3] See Appendix B for details about who participated in TWT and who responded to the surveys.
[4] Perhaps these teachers had greater difficulty incorporating technology *and* saw less need for technology to put their constructivist beliefs into practice.
[5] Scores on the constructivist beliefs and technology skills items have been shown to be highly reliable and to have predictive power with measures of constructivist teaching practices and professional use of computers by teachers (Becker, Ravitz & Wong, 1998; Ravitz, 1999)
[6] If all the teachers from Wave 1 had answered Wave 3 we cannot tell if there would have been more or less of a change. It appears Wave 3 teachers held more constructivist objectives initially but still reported a number of changes that were noteworthy.
[7] The reader is reminded that conditions for student use may be more favorable in smaller schools and lower grades in Idaho, even though teachers in high schools report more skills with technology (Ravitz, 1999; Opportunity 1 Report; Ravitz, Mergendoller & Rush, 2002).
[8] These findings are consistent with prior research indicating that smaller and younger-grade schools provide more supportive environments for teaching with a constructivist-compatible approach (Ravitz, Becker & Wong, 1999).
[9] This issue was recently emphasized in *A Conversation with Paul Light* in the Evaluation Exchange, Harvard Family Research Project, 8(2), p. 11.
[10] Prior research shows that technology skills are strongly related to professional use by teachers, but less strongly related to use with students in the classroom. Teachers with more constructivist beliefs and greater technology skills tend to use computers more frequently with students when other facilitating conditions are also present (Ravitz, 1999; Ravitz 2002).

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Appendix A. Teaching With Technology Survey, Wave #3

Thank you for filling out this survey in the past. Please fill it out one more time so we can learn about any changes that have occurred during the school year.

1. Name

First Name?

Last name:

A. You and Your Job

A1.

Name of District:

A2.

Name of School:

A3.

Grade(s) you are teaching:

A4.

Subject(s) you teach:

B. Your Teaching Philosophy

In the past we have asked you to react to statements about contrasting teaching philosophies. We are interested in your reactions now that you have had additional teaching experiences and time. The following paragraphs describe observations of two teachers' classes, Ms. Hill's and Mr. Jones'. Please answer each question below by filling in the bubble under the column that best answers that question for you.

Ms. Hill was leading her class in an animated way, asking questions that the students could answer quickly, based on the reading they had done the day before. After this review, Ms. Hill taught the class new material, again using simple questions to keep students attentive and listening.

Mr. Jones' class was also having a discussion, but many of the questions came from the students themselves. Though Mr. Jones could clarify students' questions and suggest where the students could find relevant information, he couldn't really answer most of the questions himself.

B1. How do you feel about these two approaches now?

	Definitely Ms. Hill's	Tend Towards Ms. Hill's	Can't Decide	Tend Toward Mr. Jones'	Definitely Mr. Jones'
a. Which type of class discussion are you more comfortable having?	1	2	3	4	5
b. From which type of class discussion do you think students gain more knowledge?	1	2	3	4	5

B2. Please indicate how much you disagree or agree with each of the following statements about teaching and learning, given your recent experiences.

	Strongly Disagree	Moderately Disagree	Slightly Disagree	Slightly Agree	Moderately Agree	Strongly Agree
a. Students will take more initiative to learn when they feel free to move around the room during class.	1	2	3	4	5	6
b. A quiet classroom is generally needed for effective learning.	1	2	3	4	5	6
c. It is better when the teacher - not the students - decides what activities are to be done.	1	2	3	4	5	6
d. Students should help establish criteria on which their work will be assessed.	1	2	3	4	5	6
e. Instruction should be built around problems with clear, correct answers, and around ideas that most students can grasp quickly.	1	2	3	4	5	6
f. It is very important for students to share their work outside their classroom.	1	2	3	4	5	6

B3. For the following pair of statements, please indicate how well it matches your beliefs.

"A" I mainly see my role as a facilitator. I try to provide opportunities and resources for my students to discover or construct concepts for themselves.

"B" Students really won't learn the subject unless you go over the material in a structured way. It's my job to explain, to show students how to do the work, and to assign specific practice.

	Definitely "A"	Lean toward "A"	Undecided	Lean toward "B"	Definitely "B"
My beliefs	1	2	3	4	5

B4. For the following pair of statements, please indicate how well it matches your beliefs.

"C" It is a good idea to have all sorts of activities going on in the classroom. Some students might produce a scene from a play the read. Others might create a miniature version of the set. It's hard to get the logistics right, but the successes are much more important than the failures.

"D" It is more practical to give the whole class the same assignment, one that has clear directions, and one than can be done in short intervals that match students' attention spans and the daily class schedule.

	Definitely "C"	Lean Toward "C"	Undecided	Lean Toward "D"	Definitely "D"
My Beliefs	1	2	3	4	5

B5. Based on your classroom experiences this year, how useful are each of the following kinds of assessments in determining how well students are learning?

	Not Useful	Slightly Useful	Moderately Useful	Very Useful	Essential
a. Short-answer and multiple-choice tests	1	2	3	4	5
b. Essay tests	1	2	3	4	5
c. Open-ended problems	1	2	3	4	5
d. Individual and group projects	1	2	3	4	5
e. Standardized test	1	2	3	4	5
f. Student presentations/performances	1	2	3	4	5

B6. Please mark your TOP 3 objectives for student computer use this year.

1	a. Mastering academic skills just taught, or remediating skills
2	b. Becoming better writers
3	c. Communicating electronically with other people
4	d. Finding out about ideas and information
5	e. Analyzing information
6	f. Presenting information to an audience
7	g. Learning to work collaboratively
8	h. Learning word processing skills
9	i. Learning computer skills (other than word processing)

C. Teacher Technology Proficiency

C1. Please rate the computer skills you have developed in the following areas:

	Don't Know How	Limited: Just Learning	Competent: Can Complete Satisfactorily	Expert: Can Teach Others
a. Display the directory of a disk	1	2	3	4
b. Copy files from one disk to another	1	2	3	4
c. Create a new database and establish fields and screen layouts	1	2	3	4
d. Create a word-processed document with graphics	1	2	3	4
e. Create a spreadsheet that calculates grades	1	2	3	4
f. Prepare a slide show using presentation software	1	2	3	4
g. Use a World Wide Web search engine	1	2	3	4
h. Create a Web page	1	2	3	4
i. Troubleshoot network problems	1	2	3	4
j. Develop a multimedia presentation	1	2	3	4
k. Attach files to an email message	1	2	3	4

C2. How much additional training would you like to receive in the following areas this year?

	None	Start From Scratch	Just a Refresher	Advanced Course
a. Basic computer operations (formatting disks, finding files, etc.)	1	2	3	4
b. Word processing	1	2	3	4
c. Using spreadsheets	1	2	3	4
d. Using presentation software (e.g. PowerPoint)	1	2	3	4
e. Using databases	1	2	3	4
f. Using digital imaging (scanners, digital cameras, etc.)	1	2	3	4
g. Using the World Wide Web as an instructional resource	1	2	3	4
h. Integrating technology in daily teaching and assignments	1	2	3	4
i. Creating multimedia	1	2	3	4
j. Managing students and activities when integrating technology	1	2	3	4

D. Comments on the Teaching with Technology Program

D1. Have the Technology Fellows been helpful to you during the past semester?

1 Extremely Helpful

2 Somewhat Helpful

3 Not Helpful

D2. Please comment on your above answer.

D3. Looking back at your experience, please rate the teaching models discussed during the TWT Summer Workshop in terms of how usable you found them to be in your own classroom.

	Very Usable	Somewhat Usable	Not Usable	Not Implemented
Problem Based Learning	1	2	3	4
Learning By Design	1	2	3	4
Inquiry Based Learning	1	2	3	4

D4. Please tell us more about your experience with these models.

D5. Please give a specific example of how you have incorporated one of these teaching models into your lesson plans.

D6. Looking back, has your attitude towards technology changed as a result of the Teaching with Technology project?

1 Yes

2 No

D7. IF YES, please give a specific example.

D8. Email

Please provide your email address.

Thanks for taking the time to complete this survey.

This questionnaire was created using Perseus SurveySolutions.

Appendix B. Who Participated in TWT and the Study?

It is important to acknowledge that TWT teachers were self-selected into the program. This means that they decided on their own to join and that they were therefore "ripe" for change in many ways. Teachers who were most resistant to change almost certainly did not participate in TWT; it is impossible to know if they would have changed more or less than those who did participate. At the start of TWT, those who chose to participate were substantially more skilled with technology and they were more constructivist in their beliefs than the average Idaho teachers. The following table compares the beliefs and practices of Opportunity 1 (Wave 1) teachers who did and did not participate in TWT. Data was available for teachers in secondary schools only.

Comparison of Opportunity 1 Teachers Who Did and Did Not Participate in TWT

	Middle School			High School		
Measures of Beliefs and Practice Z-scores	No TWT (N=355)	TWT (N=60)	Difference (ES)	No TWT (N=593)	TWT (N=63)	Difference (ES)
Constructivist belief index (higher score = more constructivist beliefs)	-0.08	0.42	0.50***	-0.01	0.20	0.21*
Constructivist practice index (higher score = greater technology skills)	-0.14	0.19	0.32**	0.06	0.05	-0.01
Mean Importance ascribed to computers over 5 years (higher score = more importance)	-0.12	0.13	0.25**	0.03	0.25	0.21*
Technology knowledge and skills index (higher score = more skills)	-0.19	0.69	0.89***	-0.01	0.52	0.53***
Teacher professional computer use (higher score = greater use)	-0.15	0.44	0.59***	0.00	0.41	0.41***
Teacher use with students [including games] (higher score = greater use with students)	-0.16	0.37	0.52***	0.02	0.38	0.36**

*** $p < .001$, ** $p < .03$, * $p < .10$

Note. Data is from Wave 1 only and only those who responded to Opportunity 1 surveys (not those who took pre-survey in TWT workshops). Mean scores for each grade level were 0.00 with standard deviations of 1.00. Differences for teachers in middle schools were larger than for teachers in high schools. For index scores, see Ravitz, Mergendoller, and Rush (2002) and the Final Opportunity 1 Report.

Throughout the study, we use paired t-tests to control for possible response bias. It is plausible that those teachers who responded to Wave 3 were substantially different from other teachers who participated in TWT, particularly because Wave 3 was administered online. In most cases, we limited our analysis to those for whom we did have data in Wave 3. When we compare their initial scores to those who did not complete Wave 3, there is a slight difference in technology skills, and no difference in their beliefs. Those who completed Wave 3 had significantly more technology skills in Wave 1 (ES = .18, $p < .10$), but did not differ in constructivist beliefs (ES=.03, NS) from those who did not complete Wave 3.

Some teachers may have dropped out of the surveys (not to mention the program) because they had less successful experiences. We acknowledge that the precise scores that are reported may be somewhat inflated. Instead, we focus more on where the greatest changes occurred.

Appendix C. Helpfulness of TWT Technology Fellows and Attitude Changes, by Wave 1 Pedagogical Beliefs and Technology Skills

Grade Level	Response	Constructivist Beliefs and Technology Skills, 4 categories: Less skilled with computers and less constructivist beliefs	More skilled with computers and less constructivist beliefs	Less skills with computers and more constructivist beliefs	More skills with computers and more constructivist beliefs	All teachers
All grade levels	Attitude changed?	86%	55%	79%	60%	70%
	Extremely helpful?	82	65	58	76	71
	N	*28*	*20*	*24*	*37*	*115*
	Attitude changed?	87	57	92	71	76
	Extremely helpful?	80	57	69	90	76
	N	*15*	*14*	*13*	*21*	*63*
Middle School	Attitude changed?	78	60	57	75	69
	Extremely helpful?	89	100	29	78	79
	N	*9*	*5*	*7*	*8/9*	*29*
High School	Attitude changed	100	0	75	25	56
	Extremely helpful	75	0	75	38	53
	N	*5/4*	*1*	*4*	*8*	*18*

Note. Table shows percents of teachers in each category who indicated "yes" that TWT had an impact on their technology beliefs and that TWT Technology Fellows were "extremely helpful." When there are two Ns the first indicates the number of teachers who answered "attitude changed" and the other indicates how many answered whether TWT fellows were "extremely helpful." The numbers of cases are low because many of the categorized teachers did not complete Wave 3 surveys.

Appendix D. Training Requests by Grade Level Taught, Changes from Wave 1 to Wave 3

Computer Training Request for...	Grade Level		Wave 1 teachers who did NOT answer Wave 3 (N=230)	Wave 1 teachers who DID answer Wave 3 (N=110)	Wave 3 teachers (N=110)	Difference, for those who answered both waves (N=110)
Basic computer operations	Elem	None	38%	27%	57%	30%
		Start from scratch	10	3	2	-2
		Just a refresher	39	56	24	-31
		Advanced course	13	14	18	3
	Middle School	None	37	50	67	17
		Start from scratch	10		3	3
		Just a refresher	33	50	13	-37
		Advanced course	20		17	17
	High School	None	37	50	56	6
		Start from scratch	5		0	0
		Just a refresher	46	22	33	11
		Advanced course	12	28	11	-17
Word processing	Elem	None	43	43	65	22
		Start from scratch	1			0
		Just a refresher	35	29	16	-13
		Advanced course	21	29	19	-9
	Middle School	None	48	37	58	21
		Start from scratch		3	3	0
		Just a refresher	23	33	13	-20
		Advanced course	29	27	26	-1
	High School	None	42	33	59	26
		Start from scratch	2			0
		Just a refresher	22	28	12	-16
		Advanced course	34	39	29	-10
Using Spreadsheets	Elem	None	14	18	31	13
		Start from scratch	26	18	15	-3
		Just a refresher	42	57	36	-20
		Advanced course	18	8	18	10
	Middle School	None	10	7	13	6
		Start from scratch	25	21	10	-11
		Just a refresher	48	41	42	1
		Advanced course	17	31	36	5
	High School	None	7	17	18	1
		Start from scratch	36	28	24	-4
		Just a refresher	33	39	29	-10
		Advanced course	24	17	29	13
Using Presentation Software	Elem	None	11	11	31	20
		Start from scratch	27	22		-22
		Just a refresher	38	43	47	4
		Advanced course	24	24	23	-1
	Middle School	None	12	13	27	13
		Start from scratch	27	17		-17
		Just a refresher	27	33	23	-10
		Advanced course	35	37	50	13
	High School	None	17	17	28	11
		Start from scratch	19	22	11	-11
		Just a refresher	31	28	28	0
		Advanced course	33	33	33	0

Computer Training Request for...	Grade Level		Wave 1 teachers who did NOT answer Wave 3 (N=230)	Wave 1 teachers who DID answer Wave 3 (N=110)	Wave 3 teachers (N=110)	Difference, for those who answered both waves (N=110)
Using Databases	Elem	None	10%	14%	17%	3%
		Start from scratch	35	29	22	-7
		Just a refresher	38	48	44	-4
		Advanced course	18	10	17	7
	Middle School	None	8	17	16	-1
		Start from scratch	39	23	19	-4
		Just a refresher	37	40	36	-5
		Advanced course	16	20	29	9
	High School	None	7	6	17	11
		Start from scratch	43	28	28	0
		Just a refresher	26	50	39	-11
		Advanced course	24	17	17	0
Using Digital Imaging	Elem	None	4	5	15	10
		Start from scratch	34	32	12	-20
		Just a refresher	36	33	46	13
		Advanced course	26	30	28	-2
	Middle School	None	8	3	6	3
		Start from scratch	51	50	6	-44
		Just a refresher	20	23	41	17
		Advanced course	20	23	47	24
	High School	None	7	6	22	16
		Start from scratch	33	41	17	-25
		Just a refresher	24	35	17	-19
		Advanced course	36	18	44	27
WWW as instructional resource	Elem	None	12	8	27	20
		Start from scratch	16	13	11	-1
		Just a refresher	41	37	37	1
		Advanced course	32	43	24	-19
	Middle School	None	16	17	26	9
		Start from scratch	12	10	3	-7
		Just a refresher	43	37	23	-14
		Advanced course	29	37	48	12
	High School	None	14	12	28	16
		Start from scratch	17	29	6	-24
		Just a refresher	26	35	17	-19
		Advanced course	43	24	50	27
Integrating technology in daily teaching assignments	Elem	1. None	7	2	13	12
		Start from scratch	37	30	8	-22
		Just a refresher	22	16	39	23
		Advanced course	35	52	39	-13
	Middle School	None	6	10	10	0
		Start from scratch	33	37	3	-34
		Just a refresher	27	37	42	5
		Advanced course	35	17	45	29
	High School	None	12	6	11	5
		Start from scratch	24	35		-35
		Just a refresher	14	29	28	-2
		Advanced course	50	29	61	32

Computer Training Request fo/...	Grade Level		Wave 1 teachers who did NOT answer Wave 3 (N=230)	Wave 1 teachers who DID answer Wave 3 (N=110)	Wave 3 teachers (N=110)	Difference, for those who answered both waves (N=110)
Creating Multimedia	Elem	None	6%	5%	12%	7%
		Start from scratch	46	41	17	-25
		Just a refresher	18	13	43	31
		Advanced course	30	41	28	-13
	Middle School	None	6	3	10	6
		Start from scratch	43	47	10	-37
		Just a refresher	20	27	42	15
		Advanced course	31	23	39	15
	High School	None	0	0	17	17
		Start from scratch	36	50	22	-28
		Just a refresher	29	19	6	-13
		Advanced course	36	31	56	24
Managing students when integrating technology	Elem	None	4	3	15	11
		Start from scratch	45	36	18	-18
		Just a refresher	21	21	39	18
		Advanced course	31	40	29	-11
	Middle School	None	10	7	10	3
		Start from scratch	37	47	7	-40
		Just a refresher	20	20	48	28
		Advanced course	33	27	36	9
	High School	None	5		17	17
		Start from scratch	42	35	11	-24
		Just a refresher	15	24	28	4
		Advanced course	39	41	44	3

Appendix E. Overall Changes in *Constructivist Beliefs*, Between Waves, Paired T-test Results

CHANGES in BELIEFS (Waves 1 – 2): After summer workshops (N=196 pairs)

Effect Size	Direction of change	Type of change
.44***	Constructivist	Towards Mr. Jones' more constructivist approach, comfort
.36***	Constructivist	Towards valuing of student initiative in the classroom
.34***	Constructivist	Students should establish criteria for assessments
.31***	Constructivist	Towards Mr. Jones' more constructivist approach, knowledge
-.28***	Constructivist	Away from belief in importance of structured instruction
-.30***	Constructivist	Away from belief in importance in having a quiet classroom
-.25***	Constructivist	Away from belief in using simple problems
-.20**	Constructivist	Away from belief in importance of keeping whole class on single task
-.12	Constructivist	Slightly away from belief that teacher should make all the decisions
.12	Constructivist	Slightly toward belief students should share work outside of class

CHANGES in BELIEFS (Waves 2 - 3): After 10 months of teaching (N=84 pairs)

Effect Size	Direction of change	Type of change
0.30**	Traditional	Towards belief in importance in having a quiet classroom
-0.15	Traditional	Away from valuing of student initiative in the classroom
-0.12	Traditional	Away from Mr. Jones' more constructivist approach, knowledge
0.09	Traditional	Away from Mr. Jones' more constructivist approach, comfort
0.07	Traditional	Slightly toward belief in importance of keeping whole class on single task
0.04	Traditional	Slightly towards importance of structured instruction
0.02	Traditional	Slightly towards belief that teacher should make all the decisions
-0.10	Constructivist	Slightly away from belief in using simple problems
0.12	Constructivist	Slightly towards belief students should establish criteria for assessments
0.18	Constructivist	Slightly towards believing students should share work outside of class

OVERALL CHANGES in BELIEFS (Waves 1 – 3):
From before summer workshops to end of year (N=114 pairs)

Effect Size	Direction of change	Type of change
-0.47***	Constructivist	Away from belief in importance of structured instruction
0.31**	Constructivist	Towards belief students should establish criteria for assessments
-0.30***	Constructivist	Away from belief in using simple problems
0.26**	Constructivist	Towards Mr. Jones' more constructivist approach, comfort
-0.16*	Constructivist	Away from belief in importance of keeping whole class on single task
0.15	Constructivist	Slightly towards believing students should share work outside of class
-0.15	Constructivist	Away from belief in importance in having a quiet classroom
0.12	Constructivist	Towards valuing of student initiative in the classroom
-0.12	Constructivist	Slightly away from belief that teacher should make all the decisions
08.00	Constructivist	Towards Mr. Jones' more constructivist approach, knowledge

*** p < .001, ** p < .01, * p < .10
Note. Effect size refers to change in terms of standard deviation. Statistical significance refers to how likely the result could have been caused by chance alone. See the survey in Appendix B for complete item wording.

Appendix F. Overall Changes in *Technology Skills*, Between Waves, Paired T-test Results

CHANGES in Skills (Waves 1 – 2): After summer workshops (N=142 pairs)

ES	
.81***	Develop multimedia presentation
.78***	Create web page
.54***	Troubleshoot network problems
.52***	Prepare slide show using presentation software
.34***	Display Directory of Disk
.31***	Create wp document with graphics
.30***	Copy Files between Disks
.28***	Attach files to email
.22***	Create Database
.16**	Create Spreadsheet to calculate grades
.12*	Use WWW search engine

CHANGES in Skills (Waves 2 - 3): After 10 months of teaching (N=57 pairs)

ES	
.25	Troubleshoot network problems
.24**	Attach files to email
.18**	Create wp document with graphics
.16*	Copy Files between Disks
.11	Use WWW search engine
.11	Create Spreadsheet to calculate grades
.09	Prepare slide show using presentation software
.06	Display Directory of Disk
-.11	Create Database
-.13	Develop multimedia presentation
-.31**	Create web page

OVERALL CHANGES in Skills (Waves 1 – 3):
From before workshops to end of year (N=114 pairs)

ES	
.69***	Develop multimedia presentation
.55***	Create web page
.49***	Prepare slide show using presentation software
.47***	Attach files to email
.46***	Troubleshoot network problems
.37***	Display Directory of Disk
.36***	Copy Files between Disks
.32***	Create wp document with graphics
.28***	Create Database
.12	Use WWW search engine
.10	Create Spreadsheet to calculate grades

*** $p < .001$, ** $p < .02$, * $p < .10$

Note. The lowest number of pairs is shown for each set of items. Effect size refers to change in terms of standard deviation. See the Appendix B for the actual item wording.

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