VIDEO-BASED TEACHER REFLECTION – WHAT IS THE REAL EFFECT ON REFLECTIONS OF INSERVICE TEACHERS?

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Abstract

Teachers often make instructional decisions based on favorite activities or their feelings about what works or does not. Professional development standards call for an increased focus on helping teachers collect and analyze evidence of student learning to inform revisions to instructional practices. One form of evidence that has been used is videotaped records of teachers practice. Research on the use of video has not included a comparison of video-based reflections to text-based reflections. This study examines the impact on reflections of pre-service teachers when teachers use videotaped records of practice as a tool for professional development.

Data collected in this study include pre- and post-surveys of teacher efficacy and teachers' presentations of their own analytical reflections to a group of peers. Half the teachers in the study used only text-based evidence to support their reflections, while the other half used videotapes of classroom activities. The study indicates that teachers who use video are more likely to base their reflections on evidence rather than memory or inferences. Teachers who use video also show greater increases in science teaching efficacy. The findings of the study support the use of videotaped records as a tool to support science teachers' reflection practice.

Video-based Teacher Reflection – What is the real effect on reflections of inservice teachers?

Introduction

A science teacher is looking over her curriculum at the end of the school year with intentions of revising her plans for next year. Her students do not seem to "get" the concept of cellular respiration. What should she change in her unit plans? Would it help to use a different model of respiration when she explains it? Are there labs that would help her students see how cells carry out respiration? How will she know if it works?

This is a problem that faces nearly all science teachers. Many educators make these types of decisions based on discovery of an interesting activity or suggestions of a colleague. The resulting science curriculum can become a conglomeration of labs and lectures that fail to help students understand or apply important concepts. Teacher educators, in contrast, are working to help teachers use evidence of student learning to guide decisions about curriculum and instruction as professional, reflective teachers (Zeichner & Liston, 1996).

Science teacher educators often face the challenge of offering professional development that leads teachers to make instructional decisions based on real evidence of student learning. Standards for science teacher education and staff development (NRC, 1996; NSDC, 2001) call for teachers to use data about students learning to guide revisions, but most teachers lack experience in this approach to planning.

Reflective practice (Loughran, 2002; Schon, 1983; Zeichner & Liston, 1996) is one promising approach that contributes to the growth of pedagogical content knowledge in practicing teachers. Action research, lesson study, professional learning communities, and problem-based learning are all frameworks being used for inservice teacher education that include reflection as a cornerstone activity in the learning process (Loucks-Horsley, Love, Stiles, Mundry, & Hewson, 2003).

The use of videotaped cases and records of practice has been suggested as an effective tool to promote teachers' reflective practice (Finn, 2002; Roth & Chen, 2007; Sherin & van Es, 2005) because of it's ability to help teachers notice and recall events not easily observed during the act of teaching (Fleck & Fitzpatrick, 2006; Frederiksen, Sipusic, Sherin & Wolfe, 1998). Much of the research on the impact of video-based reflections cites the benefits of using videos, but the studies do not reflect a comparison of teachers in a common context who use video cases to those whose reflections are based only on memory and written records of practice (Chen, Schwille, & Wickler, 2007; Givvin, Lemmens, & Santagata, 2007; Sherin & van Es, 2005). This gap in the literature makes it difficult to assess the real effects of video-based teacher reflections.

The Problem-Based Learning (PBL) Project for Teachers is a science teacher professional development project that supports and facilitates teacher reflective practice. One of the goals of the PBL Project is to help teachers focus their attention on systematically collected evidence of student thinking and learning. This goal presented an opportunity to compare the impact of video-based reflections on teachers' analysis of their own practice to teacher reflections based only on more traditional text-based records.

An analysis of teachers' video-based reflections by the Literacy Achievement Research Center [LARC] (Rosaen, Lundeberg, Cooper, & Kauer, 2006) suggests that teachers' reflections can be characterized by the source of information on which the reflection was based and their focus

either on teacher- or student-centered actions. This theoretical framework provided a lens for this study through which participants' reflections were assessed.

This study used a constructivist orientation (Miles & Huberman, 1994) to examine the differences in the nature of reflections by two groups of in-service science teachers. The goal of the study was to evaluate the impact of video-based reflection on teachers' understanding of their practice by comparing the reflective statements made by teachers who used videotaped records of classroom activities to teachers participating in the same group discussions who only used written records of practice.

Research Questions

This study examined the impact on the type of reflections teachers engage in when they use videotaped records as a primary form of evidence when conducting inquiry into their practice in the science classroom. In order to assess the influence of videos, the researchers compared the reflections of teachers who used both written and videotaped records of classroom activities to teachers who used only written records. The following research questions guided the collection and analysis of data:

1. What differences are evident between teachers analyzing written evidence of practice and teachers using video evidence to support reflective practice?

2. How are teachers' reflections different between the groups of teachers using written summaries and reflections as compared to those using video analysis and reflection on their classroom performance?

Design of the Study

Participants and Context

The participants in this study were a group of fifteen practicing science teachers from four counties surrounding a large midwestern university. The sample included teachers from grades 2-12. The participants were enrolled in the PBL Teacher Professional Continuum, a professional development project that uses problem-based learning (PBL) as a tool to develop teachers' science content and pedagogical knowledge.

During the 2005-6 academic year, the participants were engaged in teacher inquiry into a question they had identified related to a science lesson they planned and implemented. An important activity in the professional development program was a series of monthly "Focus on Practice" meetings in which teachers shared their reflections and analysis of their own research with a group of peers. Within each Focus on Practice group, teachers were randomly assigned to either the "Text" or "Video" groups. Members of the Text group used only written records of practice, including lesson plans, student work, test scores and observational note to support their reflections about the student learning and the design of activities. Members of the "Video" group used videotapes of classroom activities as an additional data source for the same type of reflection.

Data Sources and Analysis

Both qualitative and quantitative methods were used to identify patterns and make inferences about the differences between the two sample groups. Two primary sources of data were used to identify differences between the two groups of teachers: Science Teaching Efficacy Beliefs Inventory (STEBI) surveys, and videotaped records of teachers' presentations of

evidence and reflections in the monthly Focus on Practice meetings.

Teachers completed pre- and post-workshop (STEBI) surveys (Riggs & Enochs, 1990) as an assessment of their beliefs about their ability to teach science. The STEBI survey used for this study is a collection of 25 items scored on a 5-point Likert scale. Thirteen of the items make up a sub-score that assesses teachers' Personal Science Teaching Efficacy (PSTE) that describes a participant's confidence in his or her ability to teach science effectively. The other twelve items assess the teachers Science Teaching Outcome Efficacy (STOE) sub-score, which describes his or her confidence that effective science teaching will result in student learning. An analysis of STEBI scores for all the participants in the project had shown a significant increase in efficacy ($t_{(14)} = 2.277$, $p = 0.037$, $d = .632$). This study compared pre- and post-STEBI scores for the Video and Text groups to for the significance of differences between the two groups.

Videotaped records of the Focus on Practice group meetings in which the participants shared their reflections and analysis of their own research were also used as evidence of the types of information and topics addressed by teachers during reflection on and analysis of their teaching practice. These reflections reveal the types of events noticed by the teachers and the knowledge each teacher constructed as a result, giving the researcher insight into the participants' reflective process.

The Focus on Practice presentation videotapes were transcribed and coded using the theoretical framework adapted from the LARC analysis of video reflections (Rosaen, Lundeberg, Cooper, & Kauer, 2006). The codes labeled reflections as either teacher- or student-centered, and identified the source of information on which the reflection was based, including written evidence, videotapes, memory, and teachers' inferences. Open coding techniques (Strauss & Corbin, 1998) contributed codes to the scheme as they emerged from the data. Table 1 shows a list of codes for both Reflection Source and Reflection Subject. The Reflection Source codes identify the source of information upon which a teacher's reflections are based. Reflection Subject refers to the central topic that was described in the reflection, such as student, teacher or content. Comparison of coding of the data by two members of the research team found an inter-rater reliability of 0.899.

Table 1
Coding scheme for analyzing teachers reflections.

Reflection Source	Reflection Subject
Memory	Teacher-centered
Inference/Feeling	Student-centered
Literature	Content-centered
Peers	
Video Evidence	
Text Evidence	

Analysis of the data then involved T-test comparisons of the frequency of responses of reflections by teachers in both groups. Other variables that might have influenced the source and subject of a teacher's reflections the grade level in which the participant taught and time of year in which the teachers presented their reflections to the Focus on Practice groups. Analysis of correlations and a regression analysis were conducted to test for the relationship between these variables and the frequency of reflection responses.

Additional data included teacher responses from two different sets of interviews. A set of focus group interviews were conducted at the end of the 2006-2007 school year in which three groups of 8 teachers were asked to

discuss the impact of videotaped cases on their understanding of science teaching. Individual interviews with four repeating participants were also conducted as part of a separate study of teachers' perceptions of the professional development. Responses from all four of the repeating teachers included comments about the impact of video-based reflections on teacher learning. The focus group and individual interviews were transcribed and analyzed to look for triangulating evidence that either confirmed or refuted the themes that emerged from the FOP group presentation videos.

Findings

The data analyzed in this study are drawn primarily from teachers' responses on the pre- and post-STEBI surveys, and from videotaped presentations in which teachers shared their reflections and analysis of their own teaching practice with members of their learning community. From these data, two important themes emerged: 1) Differences in the change in science teaching efficacy between teachers in the two sample groups, and 2) differences in the attention teachers gave to evidence for their reflections. Supporting evidence from focus group and individual interviews contribute information about teachers' perceptions of the contribution of videotape records to their professional learning.

Changes in Teachers' Efficacy

An initial study of teachers' attitudes about science teaching and their self-efficacy for teaching science compared the two groups using the STEBI survey (Riggs & Enochs, 1990) to assess changes in science teaching efficacy. Changes in each group's post-STEBI scores were analyzed using ANCOVA techniques, using the pre-survey scores as a covariant. Table 2 provides a summary of the analysis of STEBI scores. The data showed that

Table 2
ANCOVA analysis of mean STEBI scores and subscores.

Test Score	Reflection Media	Pretest Mean (& *SD*)	Posttest Mean (& *SD*)	$F_{(1,12)}$
Total STEBI	Text	3.76 (.304)	3.71 (.215)	9.448*
	Video	3.64 (.370)	4.10 (.318)	
PSTE	Text	3.64 (.463)	3.39 (.318)	5.481*
	Video	3.55 (.204)	3.91 (.479)	
STOE	Text	3.87 (.204)	4.02 (.250)	9.010*
	Video	3.72 (.613)	4.29 (.491)	

*$p < .05$.

science teaching efficacy for the Video group increased significantly more than in the Text on both the PSTE sub-score ($F_{(1,12)} = 5.481$, $p = 0.037$) and the STOE ($F_{(1,12)} = 9.010$, $p = 011$). The overall STEBI scores for the Video group also increased more than in the Text group ($F_{(1,12)} = 9.448$, $p = 0.010$). The differences revealed in the Video and Text groups prompted questions about how video-based reflections might be contributing to teachers' development of efficacy.

Teachers' Reflections on Practice

Members of the Video group showed a greater increase in science teaching efficacy, suggesting that teachers' analysis of their practice might be more meaningful when they use videotaped records of practice. In order to assess how using video might lead to differences in teachers' analytical thinking, the researchers examined videotaped records of teachers' presentation of evidence and reflections at monthly learning community meetings.

The videotaped presentations represented the participants' public sharing of the evidence they collected as part of a study of their implementation of the lesson they developed during the summer PBL Project workshop. During the presentation, teachers described the context of their lesson and described their own reflections and analysis of the effectiveness of the lesson, including evidence of student learning or thinking. The reflections each teacher shared give insight into the types of information teachers used to guide revision of the structure and implementation of the lesson. Each presentation was videotaped, and the tapes were transcribed and examined using qualitative analysis techniques. Analysis included coding of each reflective comment to identify both the source and the subject of the reflections. The frequencies of each code (see Table 1) were calculated, and differences between the two groups were identified using T-test techniques.

Based on the goals of the project, two hypotheses were tested in the analysis. The first hypothesis was that teachers using video would be more likely to reflect on student actions and learning rather than the actions of the teacher. The second hypothesis predicts that teachers who use video will base more of their reflections on evidence rather than relying on memory and inferential ideas to guide reflections. Increased emphases on student learning and the use of evidence to guide instructional decisions is emphasized by the National Science Education Standards (NRC, 1996) and standards from the National Staff Development Council (NSDC, 2001).

An initial examination of the frequency of the codes assigned to the transcribed videotapes showed a large variation in the number of reflections made by teachers varied a great deal, ranging from 53 reflective statements to 148. Because of the degree of variance in coded statements, T-test comparisons were based on the percentage of each teachers' reflections labeled as "student-centered" and "evidence-based." Table 3 shows the mean percentages of each of these types of reflections with results of the T-test and effect size.

Table 3
T-test comparison of percentage of student-centered and evidence-based reflections by Text and Video groups.

Coding Category	Sample	Mean	*SD*	*t* stat	Effect size *d*
Student-centered reflections	Text	.460	.136	-1.243	.642
	Video	.549	.142		
Evidence-based reflections	Text	.208	.097	-5.643*	2.893
	Video	.455	.072		

*$p < .001$, two tailed.

The analysis of the coded responses reveals that there is no significant difference ($t_{(13)} = -1.243$, $p = .118$) in the subject of the reflections presented by teachers in each group, although there is a moderate effect size ($d = .642$). A similar comparison of the percentage of evidence-based reflections does

reveal is significant difference between the Video and Text groups ($t_{(13)} = -5.643$, $p = .00008$, $d = 2.893$). Teachers in the Video group devoted more than twice as much of their presentation to discussion of evidence than teachers in the Text Group.

The differences in the use of evidence are further illustrated by looking at the cases of two typical teachers. The following pair of examples represent teachers from each group who represent the average number of evidence-based reflections, and are presented to illustrate the differences between the two groups.

Madeleine and Carol are both teachers in a small parochial school. Both of them are experienced teachers, each with over 20 years. Madeleine teaches a variety of subjects in 6th and 7th grades, while Carol teaches in a self-contained 5th grade classroom. The two teachers are members of the same learning community. Madeleine was assigned to the Video group, and Carol is part of the Text group.

Carol's lesson was about electrical circuits, and her students experimented batteries, wires, and bulbs to understand the features of a circuit. Carol's presentation to her group in October included 66 reflective comments, only 13 of which (19.7%) were based on some form of evidence. For example, she shared copies of students' answers on worksheets:

> There were a couple of children that seemed to be right on the ball as far as knowing how the electricity constantly flows… And if you close the circuit, you do get it [the lamp to light], and if you open the circuit you don't have it. So they did a little bit better explaining this.
>
> And again on this paper, some of them did talk about the base terminal and the side terminal… but not all of them did. So I'm thinking that we're missing a few little steps.

Most of her reflections (64.6%) were based on her memory of events. In the following example, she spoke about predictions she asked students to make. After sharing copies of a few samples of diagrams her students drew to predict what a complete circuit would look like, she talked about how students avoided making predictions and jumped into the experimentation phase of the activity:

> What I was kind of disappointed in, is that although I encouraged them to try [to predict], they tried instantly to record that one before they went to the next configuration, the next drawing. They didn't want to do that. They just wanted to keep trying [different circuits].

She devoted much of her analysis of practice to recalling similar events that she felt were important but could not be captured as evidence. It is possible her memory of these events might be influenced by her opinions and interpretations, or that seeing these again in the form of a videotape of students working might show that students devoted more effort than she noticed to creating hypotheses.

Madeleine's lesson was about the refraction of light through convex and concave lenses. Like Carol, she collected samples of student work, but also videotaped her lesson and reviewed it. In her presentation, which took place in December, she shared only 56 reflective comments, of which 44.6% were based on some form of evidence. Even if we compare only the amounts of text-based evidence used, Madeleine uses more data (18.2%) than Carol to guide her analysis of her teaching.

"Note, too, on their last sheet, they did their prediction and their actual piece, which would be acceptable. It's a dotted line for their prediction and a solid line for their actual. They traced the lens but they didn't trace the light box, so it's not consistent, and they did not write up a procedure."

Both teachers seem to incorporate reflections on student work into their presentations, but Madeleine uses this form of evidence more frequently. She also uses several examples of videotape clips as evidence of student discussions:

> [Projecting video clip on the screen] So they had to come up with their predictions, and this is the better group… You can see this group thought that they [light beams] were going to diverge. They were used to using a dotted line for a prediction and a solid line for the actual.

Even though Madeleine began her analysis by looking for evidence that differentiated instruction was helping students who struggle, she began to focus her attention on a problem she noticed in how groups were functioning. She began to realize that some members of groups were not actively engaged in the experiments, something she had not noticed during the class because her attention was directed to helping small groups.

> [After projecting a video clip] See? That's what else I noticed, there was no discussion before [they did the experiment]. He's not engaged really at all in the activity.
>
> See, the boys now are shouting out everything, but he's trying to be important. But she isn't in their conversation. She isn't in the activities.

The events Madeleine focused on in her presentation included much more evidence than in Carol's presentation. Madeleine's use of videotape as a record of classroom events allowed her to notice and recall more events, and to use the tapes as evidence to inform her practice. As a result of her analysis, she restructured groups to include clearly defined roles for students that shift with each new lab to ensure that all students are participating. Her decision was based on evidence. Carol also made revisions to her teaching based on her reflections, including providing clear directions to make predictions before completing the activity. Carol's action plan, though, was based mostly on her memory of events.

Two other differences between Carol and Madeleine are the grades they teach and the date of their presentation. Because Madeleine teaches middle school science, she may be more accustomed to using evidence to guide her analysis of problems than a 5th grade teacher who has less education and experience in science. Carol's presentation on October could also have helped educate Madeleine in the process of analyzing her practice, and might have led to Madeleine's increased focus on evidence. It is helpful, therefore, to consider the correlation between these variables and the percentage of evidence-based reflections in teachers' presentations.

Testing the Relationships Between Variables

While the patterns in differences in the two sample group's changes in efficacy and teachers' use of evidence to inform their reflections is significant, there is still as possibility that the two are unrelated. To assess the strength of the association between use of video and the differences seen in the Video and Text groups, the correlations between several variables within the groups were tested. Sample group and change in STEBI scores were correlated with the percentage of evidence-based reflections, which was identified as the dependent variable. Two other factors were examined as possible variables that might influence the frequency of evidence based reflections, as well. Since two of the four members in each learning community were using video, the date of each teacher's presentation might affect how they used evidence in their analysis. Group members presenting after others had shared their analysis and reflections might have learned to

focus more of their attention on written or videotaped evidence. There may have also been a difference in the ways teachers used evidence based on the grade level they teach.

Table 4 shows correlations between these five variables. Analysis showed that there were significant correlations between the percentage of evidence-based reflections and both the sample group ($R = 0.820$, $p < 0.001$) and the change in STEBI score ($R = .706$, $p = 0.002$). Sample group and change in STEBI score also showed a significant correlation ($R = 0.545$, $p = 0.018$). Grade level taught and the date of presentation did not correlate with either the percent of evidence-based reflections, sample group, or change in STEBI score.

Table 4
Intercorrelations Between Normalized Variables Affecting % Evidence-Based Reflections

Variable	1	2	3	4	5
1. % Evidence-Based Reflections	--	0.820**	0.706**	-0.110	0.151
2. Sample Group		--	0.545*	0..058	0..378
3. Change in STEBI Score			--	-0.113	0.201
4. Grade Level Taught				--	-0.013
5. Date of Presentation					--

*$p < .05$. **$p < .01$.

To further test the relationship between the percent of evidence-based reflections, a regression analysis was conducted. Table 5 shows the results of the regression analysis. Only three variables were significant predictors of the frequency of evidence based reflections, and of those, the strongest predictor was the use of video as a source of evidence ($\beta = .824$, $p < 0.001$)

Teachers' Evaluation of Video Reflections

Analysis of patterns in nature of teachers' reflective analysis of their implementation of a lesson and their growth in science teaching efficacy indicates that video-based reflections influences teachers' thinking about their practice. In order to get other forms of evidence about the impact of video reflection on participants, the researchers collected qualitative data through individual and focus group interviews. These data provide insight into teachers' perceptions of video reflection that cannot be gained by analyzing teacher presentations and responses to the STEBI survey.

Table 5
Summary of Regression Analysis for Variables Predicting % of Evidence-based Reflections (n = 15)

Variable	*B*	*SE B*	ß
Sample Group	1.524	.199	.824**
Pre-STOE Score	-.456	.144	-.448*
Pre-PSTE Score	.265	.113	.263*

*$p < .05$. **$p < .01$.

The qualitative data include responses from a focus group questionnaire and interview conducted at the final meeting of the second cohort of participants. In these meetings, participants were asked to fill out a short

questionnaire about how analysis of videotapes influenced their understanding of science teaching. Twenty-four participants in three different focus groups, then discussed the questions. The discussions were videotaped and transcribed for analysis.

Even though about 25% of the teachers expressed some initial apprehensions about watching videotapes of their own teaching, nearly all the teachers agreed that analyzing videos helped them observe events that would otherwise escape their notice. Debra, a 30-year veteran 5th-grade teacher, described how video became an important tool in her reflections.

> Thinking about the things I chose to ask, the sequence in which I asked them, the student responses, and how I responded to students, picking that apart is hard to do after the fact unless you have the video.

Another teacher compared the use of video to "having a mirror placed in my face," elaborating that reviewing videotaped lessons allowed her to "see things that you don't notice when you are teaching the lesson." These remarks describe a very common theme in teachers' written answers as well. Amanda, a kindergarten teacher wrote about her opinion on the value of video-based reflections: "Wow! I saw so much when I viewed my tape. I found this to be the most powerful assessment."

Individual interviews with four repeating teachers also shed light on how participants view the use of video-based reflections. These interviews were intended to ask teachers about their motivation to re-enroll in the project for a second year, but all four informants talked about video analysis as an important event in their learning. Rebecca, an experience teacher in 5th and 6th grades at a small parochial school, said that she "really learned a lot from watching the videos." Her analysis helped her understand how small group interactions can help her assess students' understanding of science concepts. Kristin, an 8th-grade science teacher in a rural middle school, used videotaped records to discover that members of small groups who appear to be working together may actually be learning individually. She stated, "I never would have seen what the groups were doing without the video. I was just too busy teaching to see it!"

During an interview, Kristin gave her insight as a member of the Text group in her first year with the PBL Project who used video in her second year of participation.

> In the first year, I was glad I didn't use the video. But now that I've used videos this year, I wish I had used it last year. I learned so much by watching myself teach. I think every teacher should be required to videotape themselves, even though it's uncomfortable at first.

Teachers in the PBL Project clearly identified video-based reflection as a valuable tool in helping them understand the effectiveness of their science teaching.

Discussion

The patterns seen in the data lead to two assertions about the use of videotaped records to support reflective practice contributes to science teachers' professional development:

1. Teachers who use video are more likely to use evidence to guide their instructional decisions, and
2. Teachers who use videos to support their reflections gain confidence in their ability to help students learn science.

The following discussion explores possible explanations and implications of the patterns that emerged in the data collected in this study.

The first of the two assertions mentioned above is that teachers who use

video are more likely to focus their attention on evidence rather than on inferences, memory and "feelings" about what happened in the classroom. The National Staff Development Council (2001) calls for teacher professional development that is data-driven, and for teachers to base school improvement efforts on evidence. The findings of this data suggest that video-based teacher reflections are effective in helping teachers use data ways that align with the NSDC standards.

It also seems logical that using videotaped records would lead teachers to pay more attention to evidence. In videotapes of classroom activities, evidence that is not seen by the teacher who is occupied by moving from group to group can be captured for later analysis. Teachers also see events from a new perspective that is more durable than memory and more objective than personal inference. Classroom discussions that might fade or be altered in the teacher's mind over time can be viewed later in a form that is saved accurately. The teachers' comments recorded in focus group questionnaires and discussions also support this claim and earlier research on teachers' use of videotaped evidence (Fleck & Fitzpatrick, 2006, Frederiksen, et al, 1998) **s**uggesting that video is a valuable tool for helping teachers see and review evidence that they would otherwise overlook.

The Video group's greater use of evidence may also explain the greater increase in science teaching efficacy. Both groups of teachers showed an increase in efficacy on the STEBI survey. Desouza (2007) suggests that increases in STEBI scores may be due to increased content knowledge resulting from the summer workshop, although Morrell and Carroll (2002) found that content knowledge alone may not lead to increase efficacy. In this study, the significantly higher increase in STEBI scores among Video group members supports the claim that video-based reflections contribute to an increase in teachers' efficacy. The analysis of data also shows that other variables, including grade level taught and experience in the learning community, do not account for the increases in STEBI score.

The findings of this study suggest that the increase in efficacy is linked to an increase in the use of evidence to support teacher learning. Videotaped records helped direct teachers attention to evidence that contributed to teachers' understanding of their practice. It seems logical that increased use of evidence should lead to an increase in the teachers' confidence in their instructional decisions.

One of the hypotheses tested in the analysis of teacher presentations was that members of the Video group would focus more of their reflections on students than the Text group. Since most of the teachers videotaped students engaged in activities, one might expect a significantly greater percentage of reflections from Video group members to be student-centered. One possible explanation for the lack of significant results might be that teachers who are viewing videotapes of their own teaching for the first time could be focusing their attention on themselves. Experience with teachers in the PBL Project suggests that the first time teachers analyze their tapes they tend to notice their own actions and appearance. Members of the PBL project begin to focus less on themselves after the first or second viewing of their tapes.

Another factor that may prevent teachers from shifting toward more student-centered reflections might be the topics they identified as the driving questions in their research. For instance, Debra, the 5th-grade teacher described in the Results section chose to examine the types of questions she asked her students during lab activities. It would be appropriate when analyzing her videotapes for most of her reflections to be teacher-centered.

One other factor that may have resulted in finding no significant

differences in the reflection subject of the two groups is the small sample size even though there is was a moderate effect size. The reduced power of the T-test when sample sizes are small makes it difficult to discriminate differences in the two groups. The small sample size is a limitation to the study as a whole. While the findings lead to assertions about the impact of video-based reflections, replicating the study with a larger group of teachers would strengthen the claims supported by this study.

The assertions presented here also lead to questions worthy of further research. While the data reveal the impact of video-based reflections on teachers' efficacy and reflections, the data do not answer questions about how the use of video influences participants' science teaching practices. Further study needs to assess the changes teachers make in their curriculum and instructional strategies as a result of their analysis of videotaped records of practice. Likewise, there are currently no data published about the impact of teachers' video-based reflection on student achievement. In the current world educational atmosphere of accountability, any practices used for professional development are expected to have a positive influence on student learning and achievement.

Teachers are likely to change how they analyze and reflect on video evidence with practice. Since many participants are now entering their third consecutive year in the PBL project, the opportunity exists to conduct a longitudinal study of teachers' reflective comments over time. Such a study might show a shift in the subject of the reflections, or in the emphasis on evidence.

Videotaped records are also part of many pre-service teacher education programs, especially as components in portfolios (Miyata, 2002). Feldman (1996) found that pre-service teachers are not as skilled at reflecting on their own practice. Research comparing the impact of video-based reflections of pre-service and inservice teachers might help guide the use of videotaped records in the teacher education process.

Implications for Science Teacher Education

Reflective practice, in its many forms, has become an important part of in-service teacher education because of its emphasis on developing teachers' ability to make informed pedagogical decisions. Critical reflection based on trustworthy evidence is an integral part of a variety of professional development strategies, including action research, teacher inquiry, lesson study and professional learning communities (Loucks-Horsely, et al, 2003). The type of reflection and reasoning about pedagogy included in these strategies has even found its way into national standards for science teaching and teacher education (AAAS, 1993; National Board for Professional Teaching Standards, 2006; NCATE, 2001; NRC, 1996).

In order to support the types of teacher learning described in the standards, teacher educators need to utilize strategies that have been proven to promote deep reflections about practice. The use of videotaped records has already been used as a tool for pre-service teachers as well as for inservice teacher professional development. Patterns in the participants' reflections provide support for the use of video-based reflections as a strategy for developing teachers' ability to make reasoned instructional decisions. However, the findings of this study support expanding the use of videotaped records of practice as an important tool for helping science teachers observe, analyze, reflect on, and improve their practice. Such efforts need support from administrators and professional development providers in the form of equipment, training with video recording and editing software, and time to analyze and learn from the videos in collaborative learning communities.

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