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ABSTRACT

Recent research has focused on how prospective teachers formulate beliefs related to teaching and learning mathematics and science. This paper examines the use of videotaped mathematics and science lesson segments to aid in the description or identification of initial belief structures of prospective elementary school teachers. Using a naturalistic approach, written comments about three videotaped lesson segments were collected from 38 college students in a mathematics education content course. The videotaped lesson segments were interpreted and edited to present the prospective teachers with predetermined aspects of teaching. The three segments included a first-grade subtraction lesson, a fifth-grade math/science integrated lesson, and a second-grade constructivist mathematics lesson. Students' comments were categorized by lesson segment and analyzed across lesson-groups for commonalities and differences. Results indicate that the prospective teachers already had various preconceptions intact regarding issues of both teaching and learning before they entered the content class. Specific preconceptions are reported by lesson segment. Possible implications from the findings include: (1) the use of videotaped lessons is an effective way to identify prospective teachers' existing beliefs; (2) teacher educators cannot assume that prospective teachers' prior experiences are in conflict with teacher education objectives; and (3) consideration of these beliefs provides an opportunity for teacher educators to target those beliefs and for the prospective teachers to have an active role in their education experiences. Contains 28 references. (MDH)

The Use of Videotaped Lessons to Identify Prospective Teachers' Initial Beliefs Concerning Issues in Mathematics and Science Teacher Education

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The Use of Videotaped Lessons to Identify Prospective Teachers' Initial Beliefs Concerning Issues in Mathematics and Science Teacher Education

The recent focus in teacher thinking (Clark,1988) has generated enormous interest regarding teacher decision making and lesson planning. More specifically, this trend has served as an impetus for numerous studies on prospective teacher education--how prospective teachers come to view issues related to teaching and learning (Ball, 1988; Weinstein, 1990; Powell, 1992; Wubbels, 1992; Lederman, 1992). Three significant features appear prevalent in general education courses: the target of prospective teacher's beliefs structure; how methods courses affectively change or extend prospective teachers' instructional philosophies (Trowbridge & Bybee, 1986); and the use of technology as a medium in teacher education programs (Kinzer, Sherwood & Bransford, 1986). Present research indicates that methods courses do adequately change or affect prospective teachers' beliefs (Ball; Wilcox, Schram, Lappan & Lanier, 1990). In addition, technology has been shown to influence prospective teachers' field performance (Goldman & Barron, 1990). Often, teacher beliefs studies make use of questionnaires or testing procedures to identify or measure changes in prospective teachers' beliefs. Implicit in these procedures is the need for education courses to interpret and target beliefs so that teacher educators may provide adequate learning opportunities for those students in the education program. Thus, the rationale for identifying prospective teachers' beliefs is not questioned. Indeed, identifying those beliefs is the initial step in providing a more viable way to construct appropriate education programs for future teachers. The focus of this study is to identify, through the use of video technology, prospective teachers' initial beliefs regarding instructional practice.

The current literature relates the prospective teacher's beliefs about teaching and learning in mathematics and science to instructional practice as well as how those beliefs are affected by the teacher education program. Instructional practices include instructional strategies, methods of instruction, the role of the teacher and the learner. Further, the literature suggests prospective teachers' beliefs and teacher education are related. That is, the effectiveness of the teacher education program is dependent upon the extent to which it ignores or acknowledges those beliefs. For the remainder of this paper we will refer to this relationship as *reflexivity*. While the literature in science and mathematics education appear disparate, certain instructional practices and beliefs about those practices occur across the two disciplines. For our purposes, we will focus on those issues common or consistent to both mathematics and science education. The following discussion addresses: prospective teachers' beliefs; the affect that teacher education programs might have on changing or extending those beliefs; and the reflexive nature that exists between those beliefs and the teacher education program.

Wilcox, Schram, Lappan & Lanier (1991) found that prospective teachers perceive teaching as a matter of technical competency and asking questions. Other studies found that the prospective teacher perceived the role of the teacher as the dispenser of knowledge (Rubin & Norman, 1992; Ball, 1988). Further, Shymansky and Kyle (1992) suggested that teachers tend to perform based on their beliefs or what makes sense to them in a given situation. Feiman-Nemser and Buchmann (1985) extends this notion to include prospective teachers during their field experiences. Other studies indicate prospective teachers concentrate more on the outcomes, needs or characteristics of the learner in relation to the task at hand (Shaw & Cronin-Jones, 1989). In addition, Ball (1988) found that prospective teachers' were surprised at the students' sophisticated ways of reasoning during problem solving activities. In sum, the prospective teachers beliefs regarding instruction and the learner are diverse and appear to stem from numerous predetermined notions. The source of these beliefs is commonly associated with and constrained by the prospective teacher's pervious experiences (Ball; Wilcox, et al.; Clark, 1988; Shymansky & Kyle).

Prospective teachers also perceive mathematics as a fixed body of knowledge consisting of rules and procedures (Wilcox, et al.). Civil (1990) found that what it means for the prospective teacher to do mathematics is delimited by formal sophisticated algebraic algorithms. Using less conventional ways of solving problems (e.g., diagrams, pictures) was not considered appropriate mathematical activity. On the other hand, they view science as more than a set of ideas and relationships, that is, science is too complicated and requires tremendous efforts to be understood (Linn, 1992). The implication from these studies are of paramount importance: the prospective teachers' beliefs serve to constrain their knowledge and in turn their pedagogical content knowledge (Ball, 1988; Clark, 1988; Shymansky & Kyle, 1992). The need for teacher programs to identify and target existing beliefs seems at the core of our task as teacher educators.

Currently, teacher educators are attempting to ameliorate programs and begin to focus on those existing beliefs held by prospective teachers. Wilcox, et al. successfully created a "community of learners" and found future teachers' beliefs to change significantly during their educational experience. Similar findings have been cited by Ball (1988) and Abell and Pizzini (1992). On the other hand, Wilcox, et al. found that former students, now practicing teachers, made less and less use of methods and strategies learned during their preservice education. Over time, previously held beliefs tended to dominate and direct the novice teacher's instructional practice. Ball and others (Zeichner & Tabachnick, 1981; McDiarmid, 1990; Brousseau & Freeman, 1988; Weinstein, 1990) provide reasons for this phenomenon. Although we acknowledge that researchers should further address this phenomenon and its implications for teacher education, we agree that the teacher education programs can identify and positively affect prospective teachers' beliefs.

In regards to the reflexive nature of methods instruction and prospective teacher beliefs, Shymansky and Kyle (1992) contend that teacher's beliefs become, to some varying degree, constraints in the light of change in practice. These beliefs are seen as an accumulation of past educational experiences that influence the constraints on how learners learn, and what strategies are considered appropriate to use in a teaching situation. Other researchers believe that prospective teacher beliefs can be interpreted as ideas that could create unintended consequences in learning situations (Linn, 1992) and/or opportunities to be extended (Ball,1988). One such unintended consequence could result in preservice teachers viewing themselves as simply students in another required class rather than generalizing their learning experience and viewing or visualizing themselves as teachers.

For our purposes, the reflexive nature between methods courses and the prospective teacher is summed up in this statement:

> If I do not know what my students are thinking, what ideas, experiences and beliefs they bring with them, as well as what they understand about the ideas and experiences they encounter in the course, I will make decisions about means and goals blindly. (McDiarmid, p. 17, 1990)

Development of teacher education pedagogy from the learner's (prospective teacher's) viewpoint could lead to the developing of methods courses and some content courses that truly prepare students to become teachers who are more reflective, skilled in decision making, and who continue to grow in practicing effective teaching strategies (Cochran-Smith, 1991). Therefore, a rationale for attempting to gain an understanding of prospective teachers' beliefs concerning issues in teaching and learning is vital to the nature of teacher education.

Identifying prospective teachers beliefs has received some consideration in the literature. Weinstein (1990) suggests the that use of videotape lessons may assist in changing prospective teachers beliefs. McDiarmid (1990) has made use of videotape lessons as a means for the prospective teacher to compare and contrast two teachers' instructional practices. Further, Goldman and Barron (1990) have found the use of integrated technology to significantly affect prospective teachers' field experiences. However, there is minimal evidence that the use of videotaped lessons can serve both as a means for allowing prospective teachers to reflect on issues related to teaching and learning as well as to provide the teacher educator a way of identifying their existing beliefs (Goldman, Barron & Witherspoon, 1992). We have found the use of videotaped lessons an adequate way to identify future teachers beliefs. More significantly, we hope to show that the use of diverse lessons (traditional to unconventional instructional practices) can offer insightful information regarding the initial beliefs held by students in the education program.

Purpose of the Study

The focus of this research centers on the use of videotaped lesson segments to aid in the description or identification of initial belief structures of prospective teachers.

Data Source and Procedure

The data for this research report were collected from the written comments collected from 38 college students in a mathematics education content course at Peabody College of Vanderbilt University. The data pool consisted of 32 students who desired to begin their instruction in teacher education but had not taken a methods course, and 6 students who were already enrolled in a methods course. The researchers were both doctoral students with several years of public school experience in teaching math and science. In addition, a co-author was the actual instructor of the math education course in which the research took place.

Within the framework of qualitative research, we decided to use three video lesson segments. These segments were selected to provide a variety of instructional experiences for which the students were asked to write a description of what they saw or interpreted from the film. The data forms were given to each student with the number of the video segment at the top of the page. The instructions were written across the top of the first form. Additional time after each viewing was given to allow students to conclude their observations as needed. Forms were collected at the end of the session. The phases of the interpretation or analysis of the data emerged initially as a simple analysis of segment one, two, and then three.

Method

The naturalistic method of research was used in this study to increase our knowledge and depth of valid assessment of prospective teachers' conceptions (Lederman,1992). We felt that the qualitative or naturalistic techniques would allow us to identify the wide variety and complexity of prospective teachers' perceptions concerning specific instructional situations.

We first discussed how to handle the two influential problems or factors that often occur within qualitative research, namely, physical or psychological obtrusion and intrusion of researcher bias during judgement of data analysis (Corsaro,1985; Borg and Gall,1989; Lincoln and Guba,1985). The problem of physical and/or psychological obtrusion was minimized by limiting the direct instructions on the data form and by limiting covert expectations presented by the researchers. Some students upon receiving the form, quickly asked if they were to critique the lessons in certain formats. The same instruction was repeated to these students who had asked for further instructions. In short, we agreed that we wanted them to simply write what they saw (prospective teacher beliefs) on the film without considering the researchers expectations (expert beliefs) about each film. We recognized that the mathematical nature of the class itself might cause the students to look through a math content "lens" and respond strictly in that way. Upon first glance of the data of the first film, we found minimal influence of this factor.

In line with the nature of naturalistic type studies the definitions of terms and conceptions of categories of instruction in the data analysis were allowed to emerge (Lincoln and Guba, 1985). The initial understandings that we agreed on were centered around the definite existence of the varying perceptions that students bring with them into any learning situation including teacher education courses (Shymansky and Kyle, 1992; Enoch and Riggs, 1990) and that these would include some form of teacher and student perspectives.

We realized that a pencil and paper type questionnaire or Likert scale (i.e., STEBI B Likert scale) not only could bias the results, but could also give directional type thinking and responses to their explanations, as well as to influence their choice of terminology for what they saw (Enoch and Riggs, 1990).

The influence of the human factor on the continual emergence of issues and definitions of issues throughout and across the lesson segments defined our choice of research methodology. This study attempted to address the issues of prospective teacher's beliefs prior to taking a methods course, allowing each video lesson segment to be the impetus of influence on the beliefs of the prospective teachers in the research.

Trustworthiness

According to Lincoln and Guba (1985), trustworthiness is attained in naturalistic studies through: debriefing activities, gathering referential adequacy materials, and developing and maintaining audit trials. With these characteristics in mind, we decided to analyze the first two lessons independently of one another and meet for debriefing sessions as to whether our definitions of categories were in agreement. Secondly, the need for a variety of referential materials was met by the distinctively different data sheets that the prospective teachers' completeled. Thirdly, the development of an audit trail was realized in the emergence of definitions and the changing of our own perspective of the data as we examined the ever-changing process and product of the inquiry. We also recognized that the order in which the lesson segments were presented could influence the prospective teacher's interpretations of subsequent segments. We concluded that this ordering was random; therefore, we decided to show the subtraction lesson first followed by the math/science integrated and "constructivist" lessons, respectively. A final concern was related to the issue of external validity. Six students were enrolled in both the mathematics content course as well as the elementary mathematics methods course, concurrently. Therefore, these six prospective teachers' comments were not considered during the analysis process.

Video Segment Descriptions

Segment One: Subtraction Lesson

The five minute edited segment included the use of four visual aid activities used in a first grade classroom. The video segment was interpreted and edited to include the following: (1) an example of a teacher directed, whole class discussion with minimal (teacher selected) student participation; (2) an introduction of subtraction as "take away"; (3) an example of a math concept given in story form, i.e., "If we have three teddy bears and two run away..." and (4) an example of the transition from real life (concrete) examples such as Teddy Bears to Birds to Bubbles to Cards (numeric symbols).

In short this segment was selected to provide the preservice teacher opportunity to witness a lower elementary class' initial subtraction experience and instructional methodologies that maintain ample occasion for students to participate in "learning".

The instructional situations established in the lesson began with the teacher establishing a meaning of a story problem. The story was worded as a take-away problem. The teacher said, "If we have three teddy bears and two bears run away - I have one left." She proceeded in a second part to use the example of birds as the object of the story lesson. She called for volunteers to come to the front of the class and repeated the same type of story with children pretending to fly away. The statements, " 5 birds- and one flies away. How many are left?"were also used. As she prepared for the transition from the story type problem to the symbol problem, she asked the students about having five bubbles or balloons-two burst or pop and to find out how many are left.. In her transition to a more numerical form, the teacher used a card for each number symbol of the problem. She had a three, a two, a one, an equal sign, and a minus sign on separate pieces of poster board. Student volunteers were handed the cards as the teacher began to tell the problem. The children with the corresponding card came to the front of the group. The proper placement of these cards was emphasized and maintained in relation to the nature of the numerical problem as written in a horizontal fashion.

Segment Two: Math /Science Integration Lesson

The six minute math/science integration lesson segment involved the collection and graphing of data in a fifth grade science classroom. The data gathered originated from the dissolving of varying amounts or masses of granulated sugar into different temperatures of water. The video segment was interpreted and edited to include the following: (1) teacher directed science lesson with graphing of results; (2) teacher's use of scientifically correct and incorrect terminology; (3) teacher's use of a science demonstration and a model for graphing scientific data; and (4) an example of a teacher's recognition and handling of misconceptions in learning situations (e.g., the students put their finger in the middle of a square instead of on the points where the lines cross; the misinterpretation by the students of the "draw a line to the points" instruction).The selection and editing of this segment was to supply examples of teacher directed science and math instruction with minimal and restricted student participation.

The procedure in the class began with the teacher asking the students if they thought a certain amount of sugar could be dissolved in a specific amount of water at a definite level of temperature in degrees centigrade. The students are asked to form hypothesis and make predictions as to if they think complete dissolving will take place or not. The teacher continued to use increasing amounts of sugar with the same amount of water, but at varying degrees of temperature in different jars. The level to which the teacher has the equipment previously prepared is seen in the preparation of jars for dissolving and the graphing transparency.

The teacher shows the pairing of the numbers by placing the labeled beaker on top of the jar in which the dissolving took place. A short introduction to the use of a graph was explained as a means to share information about sugar and water. She further stated, "Which will help us to take a close look at what we have seen."

Her initial working of the graph included the explanation of the axis on the prepared graph and its increments. The graph supplied to the students matched the teacher's on the overhead. Her explanations were always made at the overhead which was at the front of the room. She first called out, "20 degrees celsius water and 200 grams sugar-Where would you put the point on the graph- Sara? (indicating that she come to the front) - (to whole class) Put your finger on it." Sara came to the over head and placed her finger in the square above the proper point (we defined this as a misconception) . The teacher handed her a pen to attempt to get her to point to a place where the lines cross. Other views of the class showed the same mistake being made throughout the classroom. After the teacher showed where Sara should have put her finger and two more examples were rehearsed, a second child was asked to come to the overhead. This time the numbers called out did indeed call for the point to be plotted other than where two lines crossed. The child continued to make the same type of mistake. This time the teacher called on whole class discussion to come to the student's aid in understanding his mistake. The student continued to stand at the front of the room during the whole class participation. After further examples the teacher gave the students the assignment to graph the three pairs of numbers that were acquired during the science section of the lesson. The final instruction was, "and draw a line to the points". The video shows the students graphing the points correctly, but drawing the line from the axis up to the points (a second misconception). The segment is concluded with a close-up of a students finished graph, which showed lines drawn connecting the points, and lines drawn upward from the x axis to each of the points.

Segment Three: Constructivist Math Lesson

The six minute edited segment included the use of a student centered approach which allowed second grade students opportunities to solve math problems using the "balancing method". This method involved the solving of problems by filling in the empty box on one side of a see-saw type structure or picture with the boxes on the other side. The video segment was interpreted and edited to include and exhibit the following: (1) examples of the natural occurrence of opportunities for the students to openly and freely discuss complex concepts; (2) examples of a teacher meeting the challenge of building the lesson from the children's concepts as they emerge; (3) examples of the students' defending and discussing the understanding or misunderstanding of the choices of other students problem solving techniques in relation to their own; and (4) examples of the students being in front of the room leading discussion instead of the teacher. The selection and editing of this video was intentionally chosen as a direct compliment of the more traditional teacher-centered or teacher-directed approach to classroom instruction.

The initial action of the teacher began with the display on the overhead of the balance problem that the students were to be discussing in their paired groups. The problem had an empty box on the left and three boxes with sixes in them on the right. The students were asked for at least four different ways of balancing the problem with the understanding that all answers were acceptable. The teacher wrote their suggestions above the picture. They suggested that the balance included 12+6=18, 13+6=18, 3x6=18, and 6x3=18. She continued by asking if there were any other suggestions.

The teacher chose a young man whose group had suggested one of the addition problems to come to the front and justify or explain their answer. A second child came forward to justify his answer using the 6x3=18 suggestion. When the student attempted to explain how he got 6x3=18, there was an increase of discussion. In particular the teacher pointed out that a young lady had a question and asked the young man to accept her question. In the resulting discussion the students moved up to the overhead screen and pointed freely to the examples. The teacher was generally out of the camera shot and, with the exception of monitoring student participation and understanding, was not directing the lesson. She cued the students to remain in the process of the learning by using terms such as, "tell us more," or "that another student has a suggestion." Other teacher directed questions and comments that were targeted to the students included, "Can we hear from you - how you did this?" and "Does that make sense to you?"

The issue that evoked the most emotion and discussion among the students was whether 6x3 and 3x6 were the same thing. The teacher continued to ask for volunteers to explain whether they agreed that these number sentences were the same or meant the same thing. The teacher attempted to bring the students back to the task by asking if they agreed. They agreed, but when asked if 6x3=18 some would not agree. Finally, the students were asked if they agreed that it was possible for these to be the same problem and most of them conceded, but that it was just a matter of how the order of the numbers fall. More than seven students came to the screen during the lesson.

Data Analysis

Analysis of the data occurred in two stages. First the comment sheets were grouped by lesson (subtraction, integrated math/science or "constructivist") and analyzed separately within lesson-segment groups. Analyses within groups included identifying statements from individual prospective teacher's comment sheets. The statements were classified systematically by identifying each statement, fitting that statement to a particular category. In some instances a comment reflected conventional educational terminology (e.g., instructional strategies, teacher questioning, student participation); in other instances we developed less conventional categories to closely fit the prospective teacher's comments (e.g., problem selection, emotional beliefs, mathematical activity). In turn, statements of the same category were summed and classified as positive, negative or neutral (see Table 1,Table 2 and Table 3). Statements that were reflective in nature (appraised issues related to the lesson) were classified as either positive or negative, whereas, statements that identified observable behaviors or stated facts regarding the lesson were classified as neutral. Our intention was to find a way to categorize comments that would allow us a way to interpret how the prospective teachers' comments reflected their initial beliefs. Grouping statements in terms of the nature of reflection (i.e., positive, negative or neutral) seemed a useful way to accomplish our objectives. Second, analyses were conducted across lesson-groups to identify commonalities or differences. These analyses included identifying the existence of certain trends within groups and reflecting those trends across groups to determine if consistencies appeared.

Results

The majority of the statements made indicated that the prospective teachers already had various preconceptions (Clark, 1988; Powell, 1992) intact regarding issues of both teaching and learning before they entered the content class. This clearly supports the vast literature associated with prospective teacher beliefs (Ball, 1989; McDiarmid, 1990; Wilcox, et al). Comments characterized issues such as instructional strategies, teacher response, visual aids, purposeful learning and numerous others. As the various categories emerged within and across lessons, our aim became to construct a way to make sense of their comments and to broaden our understanding of prospective teachers' beliefs. In line with constructivist theories, we assumed that the prospective teachers' comments were rationally based, that is, they made legitimate attempts to interpret and respond to the individual lesson segments. It was not suitable to only discuss the various categories and then make generalizations. Rather, we found it necessary to interpret their comments in terms of the degree (neutral, positive or negative) to which the prospective teachers reflected on what they observed. We were then able to identify these reflections as their "potential beliefs." Results from the individual analyses will be discussed first, followed by results that emerged across lessons.

Subtraction Lesson

Prospective teachers frequently made statements related to instructional practice, instructional strategies, visual aids, student participation and student involvement. Of the 33 comments made regarding student involvement, 20 (62.5%) were made by different prospective teachers. Thirteen prospective teachers made a total of 18 positive statements, 2 prospective teachers made a total of 3 negative statements and 10 made the 13 neutral statements (see Table 1). The following statements are representative of the more common statements made about student involvement:

> The teacher is having the class do subtraction actively. She involves and has the students participate and demonstrate what the teacher says... (neutral)
>
> I think it makes it easier for the kids when they actually participate in the demonstration--it keeps their attention and lets them realize the significance of what they are learning. (positive)
>
> Some students did not seem to be paying attention and some looked bored. (negative)
>
> I think it is neat how the students got to hold up the numbers themselves because it made it more meaningful for them. (positive).

In contrast, the prospective teachers made fewer comments regarding student participation: 9 prospective teachers made a total of 10 comments. Of the 10 comments made, 3 prospective teachers made positive statements; 1 prospective teacher made a negative statement; and 5 prospective teachers made a total of 6 neutral statements. Sample statements regarding student participation are included below:

> Class participation was set up in an encouraging environment enabling the children to speak out or correct each other. (positive)
>
> The students participate and tangibly see the math. (positive)
>
> Having the entire class scream "No!" when she asked if the boy with the equals sign was in the correct place was done very poorly... (negative).

In addition, prospective teachers who made statements regarding student involvement did not in general make statements referring to student participation, that is, of the 29 prospective teachers, 24 made comments that reflected either student participation or student involvement but not both.

From these comments we gain a sense of how the prospective teacher perceives student involvement and student participation. Involvement increases the student's understanding, makes the learning meaningful and serves to keep the student's attention. In other words, student involvement is a useful means for keeping the student attentive and enhancing "learning opportunities." Student participation seems to include when a student speaks out or corrects other students in the class. While student involvement describes what the student does (holds cards, acts in a story), student participation indicates some form or verbal response (giving answers). From the large number of responses made in reference to student involvement, we might infer that this is a significant issue for the prospective teacher is: the student should be actively involved. Further, one prospective teacher does not agree with the teacher's use of student participation to deal with a student's misconception.

We also found it useful to compare and contrast comments regarding visual aids and the use of examples. Of the 22 comments made regarding visual aids, 12 (54.5%) were made by different prospective teachers. Twelve prospective teachers made a total of 14 positive statements, 1 prospective teacher made 2 negative statements and 5 made the 7 neutral statements. Sample statements that characterize the prospective students' comments are listed below:

> The use of the signs was good too as to allow the students the way in which equations are set up. (positive)
>
> Using large visual aids (neutral)

> I would have thought a few more visual examples would have been helpful. (negative)
>
> Visual aids (cards) helped to convey complex instruction; students actually saw the step-by-step procedures of creating a problem as well as solving the problem.

In addition, the prospective teachers made fewer comments regarding the use of examples: 5 comments were made by 4 prospective teachers, all of which were characterized as positive. The following are samples of these statements:

> Using examples of birds was a good way to relate live things to math. The may help them understand that math is important in everyday life. (positive)
>
> Used everyday concepts--birds and flying away to demonstrate math concept of subtraction using knowledge already obtained and building on it to teach math. (positive)
>
> First example of the birds let the students subtract without using written shown numbers. They could see the subtraction without having to do it in their heads. (positive)

For the prospective teacher, visual aids seem to refer to the actual instructional materials or related activities whereas the use of examples relates to the purpose or usefulness of those instructional materials. Consistent with the number of responses made regarding student participation and student involvement, prospective teachers more often recognized the instructional materials or activities used rather than the their usefulness or purpose during the lesson segment.

From the above analyses, it is clear that the prospective teachers are reflecting on the lesson. It is also apparent that they display the potential to reflect on essential issues such as the appropriate use of student participation; the importance of the use of visual aids; and the use of examples to provide meaningful learning opportunities. Further, their ability to reflect on these issues seems intact prior to their formal teacher education experience.

Math /Science Integration Lesson

Upon first observation of the resulting statements of the math/science integration lesson we found a strong indication that the prospective teacher did not care for this type of lessonas evidenced by the 67% negative response. Of these 159 negative responses, the majority of the category distributions were as follows: 15 in the instructional practice category, 12 in method of instruction, 13 in teacher presentation, 19 under content issues, 17 in planning issues and 12 in purposeful learning (see Table 2). The greatest number of students making contributions to the statements were the 20 of the 25 students who responded negatively with comments pertaining to content issues. The percentage of students who actually provided comments in these highly negative categories ranged from 21.9% to the 78.1%of the total number of content-related statements.

It is important to note that the intended nature of the editing of the math/science lesson purposefully included a teaching - misconception-reteaching episode or situation, which we labeled "misconception"; an example of teacher directed non-participation lesson; and an example of a science/math integration lesson. The actual statements that occur in the data did not specifically deal with these issues as we perceived them nor as we generally speak of them, but in terms that the student perceived as occurring in this film. The trend of the thinking or terminology used by the prospective teachers was often expressed as the teacher could have or should have done... .

We found a relationship between the misconceptions concerning graphing and the type of comments given by the prospective teachers. Twenty-eight percent of the prospective teachers pointed out or reflected in some fashion on the teacher's participation in this activity. Most of the statements indicated that the handling of the misconception was not proper. Of these 9 prospective teachers, two concentrated on the first incidence of the misconception concerning graphing, while the remainder made no mention of the first incidence and point out how they think the student in the film "felt" as the teacher retaught the skill involving whole class interaction.

Examples of their comments included:

> Identifies the first child's problem with the point on a line or a box. (neutral)
>
> She incorrectly handled the kid who plotted the wrong point. (negative)
>
> They were given no indication of how to draw a line through the points. (negative)
>
> She demeans the child during the corrections (negative).

The nature of these negative remarks tends to indicate the kind of teaching situations that these prospective teachers perceive to be potentially important in science and math instruction. We think it is necessary to recognize the fact that 75% of the prospective teachers who made no statement concerning the issue of misconception is also important. It seems that some of the students switched "lenses" and began looking at the film through what they thought to be the feelings of the child. To suggest that the prospective teachers thought that more hands-on science and/or math should have been used is potentially wrong. The terminology when referring to the lesson as being boring compared to the first film is consistent with their views that the teacher is the one creating the issues or the one "in charge".

The recognition of purposeful learning as a category was determined with a 22% participation rate. 92% of these responses were negative. Re-examination of all statements revealed that these future educators blended this concern for purposeful learning into their statements about content, planning, and teacher presentation.

The consistency with which the prospective teachers commented on the math/science integration video segment is most revealing. An example of this consistency is the existence of the positive nature of most comments regarding visual aids. The visual aids or demonstration comments tend to show an acceptance for the use of such devices, but no indication that the visual aids could be used to enhance student understanding or actually be a an active part of the lesson for the learner with which to participate. Types of common statements included the following:

Big labels on equipment.(neutral)

Allowing kids to see things in different ways is good such as the use of jars, sugar, graph on the overhead. (positive)

Teacher had too many cups or containers to hold.(negative)

Inconclusion, the positive comments toward visual aids in the first film were directed toward the fact that they related to the children's world and were given opportunity to participate in the use of some of the visual aids.In contrast, the positive comments in the math/science integration film are generally refer to the fact that the teacher used a science demonstration and an over head transparency. The general consensus among the prospective teachers was that the children seemed bored.

Constructivist Lesson

Unique to the constructivist lesson is the emergence of new categories which did not appear in the previous two lessons. Comments related to inquiry mathematics (Richards, 1991; Putnam, Lampert & Peterson, 1990; Cobb, Yackel &Wood, 1989) are among those comments most frequently found, followed by student participation and student involvement. Other new categories included gender issues, peer teaching and collaborative learning (see Table 3). Of the comments made regarding inquiry mathematics (36 total), 13 prospective teachers made a total of 21 positive statements, 3 made the 4 negative statements and 10 made the 11 neutral statements. In sum, 24 different prospective teachers (or 75%) commented on the students' mathematical activity (e.g., explaining, justifying and debating answers). The following are samples of such comments:

> I like the comfortable atmosphere where the students feel free to question and discuss concepts. I think this kind of learning is beneficial to all. (positive)
>
> This last lesson intrigued me--what a great idea to let the kids argue out the rules of multiplication just as adults argue over physics problems. (positive)
>
> Concepts are examined rather than things being memorized. (positive)

> Kids discussing different perspectives. Everyone is debating different ideas. (neutral)
>
> I do not like the approach of kids arguing about this concept [6x3=3x6]. I think the teacher needs to offer more examples and direction to avoid further confusion (negative).

The positive statements here are rather revealing about what it means to do mathematics in this lesson. The prospective teacher uses such terms as "explain", "argue", "debate" and "examine" to describe the nature of the students' activity. On the other hand, the negative statement indicate that some prospective teachers did not agree with this view of doing mathematics. This less favorable response is consistent with the literature regarding prospective teachers' beliefs about learning and doing mathematics (Ball, 1990). What seems less consistent with the literature is the number of future teachers who responded positively to this lesson. Further, two prospective teachers suggested that this was by far the best of the three lessons. From our point of view this was an encouraging result.

Prospective teachers also commented on the students' involvement and participation during the lesson. The following statements represent comments regarding student involvement:

> The class is actively involved in the learning process. (neutral)
>
> The students are allowed to go up and point things out if they had questions, help, [provide] suggestions or answers; and I think this is great because here they are actively involved. (positive)
>
> The discussion seemed to really get the students involved. (neutral)
>
> What disappointed me was the fact that she didn't encourage more of the girls in the class to participate in figuring out the problem. (negative)
>
> A lot of discussionis taking place in the classroom, which involves other students as well as the teacher (neutral).

The following comments are sample statements made by the prospective teacher regarding student participation include:

> I was impressed with the student participation in this lesson--the kids really seem interested. (positive)

> This lesson allowed a lot of participation from a lot of children. (neutral)
>
> Entire class participation (neutral)
>
> Both [the teacher and the students] were equal participants in the lesson (neutral).

Although student participation and student involvement were originally dealt with separately in our analysis, there is less distinction between these two categories in this lesson. In contrast to the subtraction lesson, what it means for a student to be actively involved in this lesson includes questioning, giving answers and helping other students explain their answers. "Actively involved" in the first lesson was described as the student holding cards or acting out a story. Here, student involvement is characterized by the students engaged in mathematical discussion. While comments regarding student participation were not as frequent in this lesson, one prospective teacher did comment that the teacher and the student are equal participants in this lesson. Not all comments were favorable regarding the lesson. Two prospective teachers mentioned the lack of female participation during the whole-class discussion.

Analysis Across Lessons

In our final analysis, we compared existing trends within categories across the three lessons. We found that prospective teachers frequently mentioned student participation and student involvement. More specifically, what it means for the student to participate in the lesson shifted with each subsequent lesson segment. In the subtraction lesson, student participation was often mentioned in conjunction with opportunities for the student to learn. While fewer comments were made about student participation in the math/science lesson, there was less opportunity for the students to participate in this lesson. Those comments made were usually negative and suggested how student involvement might be incorporated to improve the lesson. The kinds of comments in the third lesson further supported and extended the prospective teachers' ideas about what it means to participate or be involved in the lesson. Participation in the third lesson included explaining and justifying of answers. In sum, it seems the prospective teacher perceives student involvement or participation to be a significant feature in these lessons.

Visual aids were also frequently addressed by the prospective teachers. While visual aids appeared to assist students during the learning process in the first lesson segment, the prospective teachers often mentioned the use but not the purpose of the instructional materials during the math/science lesson. Some prospective teachers even indicated that they saw no meaning or purpose for the materials.

Other categories seemed distinct to one lesson or another. For example, the frequent use of real life examples in the subtraction lesson did not seem to occur in the other lessons. Similarly, inquiry mathematics did not emerge until the third lesson.

Implications

This study suggests that the use of videotaped lesson segments is a useful way to identify prospective teachers' potential beliefs. The underlying assumption of this study is that identifying prospective teachers' initial beliefs is a first step in developing the appropriate kinds of teacher education programs needed. Below we list possible implications from our findings:

1) The use of videotaped lessons is an effective way to identify prospective teachers' existing beliefs.

2) The potential beliefs of the prospective teachers surpassed our current understanding of what they bring into the education program, i.e., we cannot assume that their previous experiences are all in conflict with our objectives as teacher educators.

3) Consideration of these beliefs provides an opportunity for the prospective teachers to have an active role in their education experiences. More specifically, the teacher educator can then target those beliefs--identify misconceptions and/or extend those beliefs considered in line with the goals and objectives of the teacher education program.

Finally, prospective teachers often reflect on issues related to teaching and learning prior to their formal teacher education experience. In this study, we get a sense of what those beliefs are as well as the potential that exists to extend those currently held beliefs. The implications of these findings provide additional understanding as to how we might begin to develop ways to assist prospective teachers in becoming effective, reflective teachers.

Table 1

Subtraction Lesson: Prospective Teachers' Comments

Category	Positive Comments	Negative Comments	Neutral Comments	Comments per Category	Students per Category
Visual Aids	11	2	6	19	14
Instructional Practice	3	1	1	5	4
Instructional Strategies	9	2	4	15	12
Content Issues	4	3	6	9	13
Teacher Questioning	4	0	6	10	6
Teacher Explanation	1	1	0	2	1
Student Participation	5	2	11	18	12
Student Involvement	12	1	6	19	13
Method of Instruction	4	3	3	10	8
Risk Taking by the Learner	0	0	1	1	1
Every Day Math/ Purposeful Learning	3	0	0	3	3
Student Interest	5	2	0	7	7
Teacher Presentation	1	1	1	3	2
Ways of Learning	2	0	0	2	2
Teacher Interaction	1	0	0	1	1
Assessment of the Learning	1	0	0	1	1
Construction of Knowledge Base	1	0	0	1	1
Problem Selection	1	0	0	1	1
Meaningful Learning	5	0	0	5	3
Knowledge of the Learning	0	1	0	1	1
Transfer of the Learning	0	3	2	5	5
Developing Understanding	6	1	1	8	8
Culture of the Classroom	0	0	1	1	1
Classroom Management	2	2	1	5	5
Planning Issues	3	0	0	3	3
Constructs of the Classroom	0	0	1	1	1
Use of Examples	5	0	0	5	4
Mathematical Activity	1	0	0	1	1
Math Confidence	1	0	0	1	1
Use of Background Knowledge	2	0	0	1	1
Value of the Lesson	1	0	0	1	1
Targeting the Learning	0	0	1	1	1
Teacher Response	0	2	0	2	1
Student Interpretation	0	0	1	1	1
Effective Learning	0	0	1	1	1

All entries represent the number of responses made by prospective teachers, n = 32.

Table 2

Integrated Math/Science Lesson: Prospective Teachers' Comments

Category	Positive Comments	Negative Comments	Neutral Comments	Comments per Category	Students per Category
Visual Aids	13	1	6	20	13
Instructional Practice	7	15	6	28	16
Integration Issue	3	5	1	9	9
Method of Instruction	3	12	5	20	18
Teacher Presentation	0	13	3	16	11
Content Issues	10	19	4	33	25
Planning Issues	5	17	1	23	17
Student Interest	1	8	0	9	7
Student Participation	4	8	7	19	13
Student Involvement	0	2	1	3	3
Instructional Strategy	6	2	7	15	11
Appropriate Level/Content	0	1	1	2	2
Purposeful Learning	0	12	1	13	7
Time Management	0	6	1	7	5
Transition Classroom Management	0	2	0	2	2
Student Understanding	1	4	3	8	7
Construction Knowledge Base	0	2	0	2	2
Misconception	3	4	2	9	8
Teacher Interaction	0	1	0	1	1

All entries represent the number of responses made by prospective teachers, n = 32.

Table 3

Constructivist Lesson: Prospective Teachers' Comments

Category	Positive Comments	Negative Comments	Neutral Comments	Comments per Category	Students per Category
Student Understanding	3	2	2	7	7
Student Involvement	4	1	7	12	11
Student Questioning	1	0	1	2	2
Collaborative Learning	4	0	2	6	6
Issues Pertaining to the Lesson	2	0	0	2	2
Instructional Practice	12	6	2	20	10
Inquiry Mathematics	21	4	11	36	224
Content Issues	2	2	11	15	10
Methods of Instruction	5	1	3	9	8
Student Participation	9	2	12	23	14
Culture of the Classroom	2	1	1	4	4
Instructional Materials	4	1	4	9	9
Student Interest	3	0	3	6	6
Teacher Questioning	3	0	3	6	6
Classroom Management	3	4	1	8	8
Teacher Response	1	1	0	2	2
Peer Teaching	3	0	2	5	5
Gender Issues	0	1	1	2	2
Monitoring the Learning	0	0	1	1	1
Student /Teacher Interaction	0	0	1	1	1
Promoting Thinking Skills	2	0	4	5	4
Student Interaction	0	1	1	2	2
Emotional Beliefs	1	0	0	1	1
Facilitator of the Learning	0	0	2	2	2
Risk Taking by the Learner	1	0	1	1	1
Problem Solving	1	0	1	2	2

All entries represent the number of responses made by prospective teachers, n = 32.

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