DOCUMENT RESUME

ED 381 500 SP 035 869

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TITLE Authority and Relativism "in the Trenches": A Case Study of Teacher Development.
PUB DATE Oct 94
NOTE 31p.; Paper presented at the Annual Meeting of the Northeastern Educational Research Association (Ellenville, NY, October 1994).
PUB TYPE Speeches/Conference Papers (150) -- Reports - Research/Technical (143)

EDRS PRICE MF01/PC02 Plus Postage.
DESCRIPTORS *Beginning Teachers; *Beliefs; Case Studies; Field Experience Programs; Higher Education; High Schools; Interviews; *Mathematics Education; Methods Courses; Preservice Teacher Education; *Professional Development; Secondary School Mathematics; Secondary School Teachers; Student Development; *Student Teachers; *Teacher Attitudes; Teaching Experience
IDENTIFIERS *Teacher Development

ABSTRACT

A preservice teacher was interviewed 10 times during his last year of teacher education, when he participated in several mathematics teacher education courses and field experiences, and his first year of high school teaching. The case study was designed to develop an understanding of the teacher development process by considering how one teacher developed or resisted new ideas, struggled with reconciling new ideas with his existing beliefs and structures of beliefs, and attempted to put new ideas into practice in the classroom. The study considered how classroom constraints (perceived or real) and the teacher's existing structure of beliefs affected the enactment and/or modification of beliefs. The case study followed the teacher's development in: initial understandings of mathematics and teaching, search for affirmation of beliefs, classroom organization, relating to students, role as a teacher, relating to peers, concerns about external constraints, and continuing growth. Themes in the teacher's belief system included "making mathematics interesting," "problem solving," "structure and control," and "helping people." Conflicts encountered in this belief structure as a result of teaching experience forced him to readjust and redefine his beliefs. Implications for teacher education are outlined. (Contains 19 references.) (JDD)

AUTHORITY AND RELATIVISM "IN THE TRENCHES": A CASE STUDY OF TEACHER DEVELOPMENT

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Paper presented at the annual meeting of the Northeastern Educational Research Association, Ellenville, NY, October 1994. A portion of this research was supported by the National Science Foundation, TPE 9050016, Thomas J. Cooney, Project Director.

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With the current climate of reform in mathematics education, teacher development naturally becomes an important area of inquiry (Cooney, 1993). One indicator of the need for this inquiry comes from research in teachers' beliefs (Thompson, 1992). This research demonstrates the difficulties faced in having an impact on teachers' beliefs and in seeing newly developed beliefs enacted in reformed practices in the classroom. The purpose of this study is to begin to develop an understanding of the teacher development process by considering cases of teacher development. Particularly, I consider how one teacher, Todd, developed or resisted new ideas, struggled with reconciling new ideas with his existing beliefs and structures of beliefs, and attempted to put new ideas in practice in the classroom. Also, I consider how the constraints (perceived or real) of the classroom and Todd's existing structure of beliefs affected the enaction and/or modification of beliefs.

The assumption that learning, including learning to teach, is an adaptive process provides a basis for this study (von Glasersfeld, 1987; Cooney, 1994). In this process, the learner interacts with his or her environment and constructs schemes to organize this experience. The study focuses on the teacher's own organizing process that is dependent on the existing cognitive structure of the individual teacher (Maturana, 1978). Understanding this organizing process may involve looking first at the teacher's present organization of beliefs (common to teachers' belief research) and then considering the nature of beliefs in light of change or resistance to change. For the organization of the teacher's beliefs, this study incorporates the three dimensions of belief systems described by Green (1971) which consider connections among beliefs, strength of commitment to beliefs, and clustering or isolation of belief subsystems. The

nature of beliefs, particularly in terms of orientation to authority, is also important in this study for understanding a person's belief changes or resistance to change (Cooney, 1993). Thus, I consider the moral development scheme of Perry (1970) and Belenky, Clichy, Goldberger, and Tarule's (1986) ways of knowing.

RESEARCH METHODS

Participant Selection

Todd was selected in the fall of 1992 from a group of eighteen preservice secondary mathematics teachers beginning the last year of their teacher education program. It is during this last year of the program that the teachers participate in several mathematics teacher education courses and field experiences. The initial selection was based on responses to a questionnaire through which Todd shared his views on mathematics and teaching mathematics and classroom observation field notes collected by the instructor and a graduate assistant who observed the class. Todd was a strong mathematics student (as evidenced by performance in prior mathematics courses and observations of his interactions with peers in the classroom). Further, Todd expressed well-developed ideas about teaching and mathematics and was excited about the reform-related ideas presented in his teacher education program. Todd seemed to represent a teacher who would develop a strong pedagogical knowledge-base that would support the type of teaching called for in current reform documents (e.g., NCTM, 1989, 1991). I documented Todd's process of adopting these reform ideas and then his process of implementing them in his classroom during his first year of teaching (for a similar case, see Cooney, 1985). Todd contrasts with the more at-risk preservice teachers who either see the teacher education program as a medium for passively transferring information that will make the teacher a good teacher (e.g., Nancy in Shealy, Arvold, Zheng, & Cooney, 1994) or the teacher who is dismissive or even hostile toward the teacher education program (e.g., Henry in Arvold, 1994; Shealy, Arvold, Zheng, & Cooney, 1994).

Data Collection and Analysis

I interviewed Todd five times at critical junctures during his 1992-1993 teacher education program (e.g., entering the program, after field experiences, the end of the program). He was then interviewed five times over the course of his first year of teaching (1993-1994). Each interview followed up on analysis of previous data and to be open to Todd's own construction of his teaching experience. I observed Todd's teaching in field experiences during his teacher education program and for three to five days on three separate occasions (fall, winter, and spring) during his first year of teaching. Written artifacts (e.g., journal entries, questionnaires, assignments he gave his students, and a grant proposal he wrote) and field notes of Todd's interactions with peers and students were also analyzed. After developing and organizing themes from Todd's data through a process of constant comparative analysis (Strauss, 1987), I reconsidered this organization in terms of Green's (1971) three dimensions of belief systems (essentially connections between beliefs and structures of beliefs, commitment to beliefs, and clustering and isolation of beliefs and belief substructures). This inferred structure of Todd's beliefs provided a basis for finding evidence of Todd's relation to authority in terms of Perry's (1970) moral development scheme and Belenky, et al.'s (1986) ways of knowing.

CASE STUDY OF TODD

Todd grew up in a suburb of Atlanta, Georgia. He had been a good student in high school and afterwards pursued engineering studies at a suburban state technological college. Todd had a good relationship with his family and continued to live at home through the two years of his engineering study. For financial reasons, Todd wanted to complete his studies in four years. After two years he realized he would not be able to finish in this time frame. Todd worked for a tutorial service as many as twenty hours a week tutoring high school students in mathematics. This tutoring experience and the time pressure Todd felt led him to transfer to the University

of Georgia and prepare to teach high school mathematics. Todd continued to live at home and make the one to two hour commute to the university while continuing to work at his tutoring job.

Todd's mathematics teacher education program included a "problem solving" course involving investigation of mathematical situations, two teaching methods courses, and two courses addressing technology use in the classroom. These courses were taken over the course of three quarters (summer and fall of 1992 and winter of 1993) and were followed by student teaching in the spring of 1993 and a post-student teaching seminar in the summer of 1994. All of the courses were inquiry-oriented in the sense that pedagogical and mathematical content issues were situated in open-ended investigations. Interviews conducted with the two methods course instructors indicated the instructors shared values incorporated into their courses.

During Todd's first year of teaching (1993-1994), he taught at the older of two high schools in a predominately rural county that in recent years began to be engulfed by the Atlanta urban sprawl. The county is growing rapidly and quickly becoming a bedroom community with the building of new subdivisions and apartment complexes. This growth forced the county to build a new high school in the predominantly suburban part of the county. Todd's school enrolled about 1800 students and had a space problem. Because of the changing demographics of the county, the students came from a variety of socio-economic situations, but with few ethnic minorities.

The case study that follows traces Todd's development as a teacher in terms of the nature and organization of his beliefs over the course of his last year of teacher education and his first year of teaching.

Todd as a Preservice Teacher

Todd's Initial Understandings of Mathematics and Teaching

Todd raised the two themes of "interested in mathematics" and "problem solving" repeatedly early in his preservice teacher education program. These two

themes were prominent in Todd's thinking about mathematics and teaching. All that Todd heard in his teacher education program seemed to confirm his beliefs that mathematics was much more interesting than what he had experienced as school mathematics, that the teacher should make mathematics interesting, and that problem-solving skills were extremely important. Todd held a strong conviction about what kind of teacher he wanted to be when he entered his teacher education courses. He hoped to work out the details of how to become this type of teacher.

Interested in Mathematics

When Todd reflected on his own experience learning school mathematics, he remembered being bored. He said the worst experience that he had in learning mathematics was just sitting in the classroom and listening to the teacher lecture. This sitting and listening was characteristic of both his high school experience and much of his college experience. He said, however, that "a light bulb [came on]" during his engineering and physics classes at the technical college as he studied mathematics applied to "real life." This excitement gave Todd the desire to transform school mathematics in order to give students a better experience with learning mathematics founded in the interest generated by applications.

Problem Solving

Todd believed that problem solving should be at the center of teaching and learning mathematics. The first course he took in the mathematics education department enforced this belief. This "problem solving" course involved open-ended investigations of a variety of problems set in both real world and abstract mathematical situations. He said,

> I really think what's important in problem solving is that they need to be able to make the connections of math to the real world. And that's one of the [objectives] that I value because my main objective is to get my students to think

while they're in math class. . . . I thought it was, it's meant to be more of a thinking and creative problem solving process. (February 1993)

He believed that mathematics is the best place to develop these reasoning and problem-solving skills.

Todd's Search for Affirmation

Over the course of Todd's teacher education program, Todd said several times that his experiences with the courses confirmed his views of teaching. He mentioned his professors and the NCTM Standards as reflecting those views. As he progressed through the teacher education program, he elaborated on the themes of problem solving and interest. During the course of his preservice experience, however, two new themes became evident as Todd discussed his ideas of teaching and, in some ways, these themes took precedence over the original themes. These new themes were concern for "structure and control" and "helping students."

Developing the Problem Solving and Interest Themes

Over the course of the year, Todd elaborated on what he meant by interesting mathematics and problem solving. Todd said that mathematics is more of a "thinking and problem solving process" as opposed to a "routine of memorize some formula and find the unknowns" (February 1993). Seeing mathematics then as the best place to develop reasoning skills, Todd turned to the question of how to help students develop this skill. Todd said he would first let "the student explore and discover for themselves rather than showing them how to go about problem solving or some of the methods they might want to use." Then, after this period of exploration, he would "coach them towards the right type of goal or thinking, their own method, but maybe help them, to encourage them to get them to that goal of their own thinking" (February 1993). This coaching could take the form of giving "them some possible examples of ways to approach this problem. I mean not just one specific set way, several, as many as I could possibly come up with on my own."

Helping Students

The idea of helping students develop their own thinking is another theme that became more evident in Todd's thinking during this year. Todd felt good about helping people and, as a teacher, felt he would be helping people. "I was also tutoring to help other math students and I found that to be fun—to show some students. And I guess it was rewarding to see some other students excel because of what you've helped them with" (February 1993). For Todd, helping meant giving examples and models and showing someone how to do a problem. Todd's extensive experience tutoring individual students one-on-one contributed to this understanding of helping.

Todd seemed to place much value on the help he was able to provide students. He talked about students excelling because of his help and stressed the importance of his developing his own enthusiasm and knowledge so that he could be in a better position to help the students.

Structure and Control

Late in the fall of 1992, Todd became preoccupied with coming up with creative ways of controlling the students in the classroom. For example, he said at one point he would take out a stopwatch whenever the students were off task and accumulate that time over the course of the week. On Fridays, he would plan fifteen minutes of free time and deduct this off-task time from that free time. For a while during the winter leading up to his first classroom field experience, Todd seemed insecure about teaching. He said about classroom management, "I have so many questions that I want to be answered before I'm expected to go out into teaching." Later in the spring, he said that the classroom management was probably the overall thing that stood out in his mind during his student teaching. He had expected to acquire this knowledge from his teacher education courses. He was eager to learn how to handle certain problems, especially how to deal with problem students. He wished the methods courses had addressed classroom management in more detail. To some extent, his spirit went up

and down along with his success and failure during his field experiences and with others' reaction towards his managerial skills. For instance, during his student teaching, he felt very disappointed when one of his cooperative teachers repeatedly failed to confirm the positive things he felt he did in the class.

Summary

As Todd moved from his preservice to inservice experience as a teacher several issues and conflicts were important to anticipate and investigate. Todd clearly acknowledged differing views on teaching but valued "more progressive" styles over "traditional." He felt that his experience with learning mathematics and teaching with a "traditional" cooperating teacher provided him with negative teaching examples and that he wished he had more positive examples. This evaluation along with Todd's expressed desire to be a reforming influence in his school, gradually implementing new ideas, seemed to indicate Todd was in the stages of modifying dualism described by Perry (1970). Although he recognized differing views, he had a tendency to see himself in the camp of those with the correct views of education.

The themes of "problem solving" and "making mathematics interesting" had already come into conflict with the themes of "structure and control" and "helping people." Todd still emphasized the students investigating problems on their own and developing reasoning skills as opposed to rote memorization. Time and curricular (cf. "objective mathematics") constraints as well as classroom control problems challenged his picture of what he wanted to happen in his classroom. It seemed that there was a degree of clustering or isolation (Green, 1971) between these themes in Todd's belief system. Rokeach (1968) said that one way of challenging this isolation is to place the person in contexts where the belief substructures are forced into conflict. Todd was in just such a situation as he moved into the classroom as a full-time teacher.

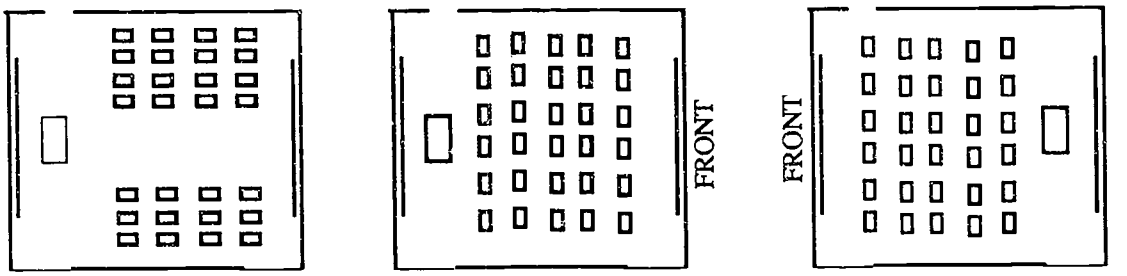
Todd as a First-Year Teacher

At the beginning of the school year, Todd taught two Algebra classes, two Geometry classes, and a Pre-Algebra class. Halfway through the first semester, a veteran teacher left and Todd's received a new schedule dropping his Pre-Algebra class and picking up an Advanced Placement Calculus course. During the spring semester, Todd taught two Algebra classes, a Geometry B class, and Advanced Placement Calculus. When the teacher left, Todd also inherited duties as systems operator for the school's computer network. During the Spring semester, Todd received an additional free period to help him accomplish the systems operator duties. In addition to these duties, Todd coached the junior varsity softball team in the Fall and a junior varsity baseball team in the Spring. He also continued to work at a tutorial center and was preparing to be married in June.

Todd's Classroom

Todd's classroom was much like any classroom in an older high school. The wall opposite the door at one time contained windows over its full length, the center windows have been replaced. There are blackboards across the walls at each end of the room. The wall with the door has a bulletin board with various mathematics-related items attached Todd placed on the board at the beginning of the year and that have remained untouched the rest of the year. Todd's desk is at the back of the room and is littered with papers, books, and mathematical puzzles. In December, when you walk in the door you are at the front of the room. This was the third room arrangement Todd has had (Figure 1). Early in the year, Todd arranged his desks in two sections of rows facing the center of the room. Todd said this arrangement gave him room to move around and allowed him to use the boards on both ends of the room. In December, Todd rearranged the desks into rows and columns with his desk at the back of the room. Later, Todd turned everything around to switch the front and back of the class. Todd liked this arrangement because he can get to the students when they are working

individually and "there isn't a back of the room," that is, when Todd was teaching he was at one end of the room and when he was at the desk he was behind the students, thus he could easily be behind any student and "no one can hide." So, Todd liked this arrangement because it allowed for greater control over the students in his classroom.



October February April

Figure 1. Transition in Todd's classroom configuration.

As Todd teaches, his speech and the overall pace of the class are very fast. Thus, if someone considered a transcript of Todd's class, his statements and the students' responses would often not complete sentences. Todd moves from one topic to another often without transition, although following a logical progression. It seems that because some of his students have gotten used to this style, some unspoken communication is evident. An observer may often wonder both how the students knew what Todd was talking about and how Todd understood what a particular student was saying. Otherwise, Todd often misunderstood or even missed completely what a student said in the class. Many of the students tune Todd out quickly and do not pay attention. In some classes this inattention leads to disruptions. Part of the reason that Todd moves through the lecture so quickly is so he may enter what might be called his tutor mode—working individually with students. Todd devotes a significant part of each class to helping students as they work individually.

Todd is very energetic and his classes are generally very intense. After going over the homework, Todd explains the new topic. The introduction of the new topic takes the form of a series of questions that lead to the development of the new concept (the derivation of a formula, etc.). Todd asks these questions of the students, but asks the questions so quickly that combined with the generally rapid pace of the class, he gives the students little time to answer. When the students do not answer immediately, he either answers the question himself or rephrases the question to make it easier (cf. Bauersfeld's, 1988, description of the "funnel" pattern of teacher-student interaction). When the students do respond, the responses are usually very short answers and sometimes nonsensical. Following this introduction, Todd will work several example problems getting the students to give intermediate results.

During the last segment of the lesson, Todd gives the students a worksheet or assignment from the book and has them work individually at their desks, completing the assignment at home. Todd often ends up doing several of the assigned problems for the class on the board. During this time Todd circulates around the room helping individual students or groups of students, usually explaining how to do problems or leading them to take the next step in a problem. He seems to think his helping the students individually is the most helpful part of the class.

Todd commonly had open-ended, non-routine problems for the students as bonus problems at the end of the period or on the end of a worksheet. The students who answered these problems most quickly got a piece of candy. These problems, however, were seldom connected to the topic at hand. Todd used these problems to generate student interest in mathematics and to help the students develop problem-solving skills. He hoped this interest and these skills would transfer to the curriculum.

Todd as an Inservice Teacher

Relating to Students

The "helping people" theme that arose in Todd's preservice year was more explicit in his inservice year. Consider Todd's relationship to his students. Todd clearly related well with his students. They liked him and talked to him between classes and before and after school. He said he most enjoyed the feeling that he was benefiting or helping them. "I'm very happy when I'm teaching. I'm doing something I like to do. I'm helping people. I enjoy doing that. I enjoy going to school every day, coming up here and going to work. I guess it's kind of a job that makes you feel good about what you're doing because you're actually trying to help other people. You're doing something positive."

For Todd, "helping people" had a very specific meaning—helping them with their mathematics. Todd spent hours after school each day helping students, talked about helping students with homework at basketball and baseball games, and spent a large portion of most class periods helping students individually. He said, "Ask any of the faculty and they will tell you they see [my] little green car in the parking lot late at night" (February 1994). Also, much of Todd's interaction outside class was mathematical in nature. Students came by to talk about a bonus problem or puzzle he had given. Students came by to talk about homework, while others talked about the games and puzzles he keeps in his desk. Students tried to confide in Todd concerning their personal and family problems. But since "helping people" meant helping them with the mathematics for Todd, he always prefaced these conversations with his legal requirement to tell counselors or appropriate authorities in certain cases. He said that some students were not speaking to him now because he would not keep their confidence.

Thus, Todd, in helping students, was concerned about understanding the individual student's mathematical weaknesses and helping the student individually to

correct those weaknesses. Then, Todd would go out of his way to help them learn new concepts, grow mathematically, and become prepared for when they next have to use the mathematics. His students appreciated the individual attention and depended on that help. Because of Todd's role as a teacher and authority, he maintained a certain separation and limits between himself and the students. Which led some student to be disappointed in their relationship with him.

Role as a Teacher

Todd said teaching is "helping students visualize and understand and learn and grow, mature mentally and physically and just helping them to grow" (February 1994). This statement again punctuated Todd's idea of helping people as described above. He did this helping by providing input to all of the students' senses. "The more input you can give them the better—from all the different senses. They can feel, touch, look, see, and hear, they heard me talking about it. I can't think of a name for that where you bombard the senses basically. The more input you can give them about something the better you are" (February 1994).

As Todd's year progressed, another important emphasis led to conflict with his role as and means of being a motivator. For Todd, the teacher must also be in control of the classroom and provide structure for the students. Early in the year, Todd had classroom management problems particularly with one class. He said that this was frustrating because he found that teaching was "control first and teaching second" (October 1993). He said that if a few students are not under control it hurts the rest of the students. Thus, Todd found it important to have the class highly structured. In one activity he said he added "a lot of structure, and so, all the students have an assigned task to be done at all times." According to Todd, the students liked this structure. He had difficulty separating the students' role from his own. Beyond being attentive and working he said they needed interest and excitement, but it was Todd's responsibility to make the class interesting and exciting. Todd's role as a teacher was to

help the students develop mathematics and reasoning skills by providing input based on their individual needs and interesting and motivating them to apply themselves.

Relating to Peers

Todd did not talk about his peers unless explicitly asked. He had trouble identifying situations where he has sought advice from his peers. He had little interaction over teaching issues and generally disagreed with what advice he received, especially concerning classroom management issues. He felt that his peers were more traditional teachers with outdated ideas. At times he indicated his peers were impressed with him; at other times he said they are wary of him. Todd believed the school and district tried to be more progressive, but saw the faculty as more conservative. He said,

> I like the fact that [the school is] really trying to grow and it's trying to push in the right direction and so the person with the right initiative, I guess, can really push. . . . The only thing I'm worried is that . . . I guess as a first year teacher I might be doing a little bit too much, too fast. I guess I'm a first year teacher and I'm suppose to hold back a little bit and not do these things right away. I kind of get that sense from them sometimes.

He went on to say,

> I do think some people are a little bit afraid of all this change happening so fast and this is happening real fast here in [the county]. I mean things are changing in leaps and bounds and I think a lot of people are afraid of that because they've been used to teaching how [the county] used to be, but it's not going to be that way anymore because it's growing so fast. . . . I'm just worried that I, like I said, I'm not going too fast with some of my own ideas and I don't mean to force my ideas on anyone else. (October 1993)

Todd exhibited an aloofness or self-sufficiency in relating to peers. He was friendly, not wanting to push his ideas too quickly, but he had his own agenda. This seeming

arrogance, was more the outward signs of Todd seeking find his own voice and a safe place to stand. The educational reform movement he saw embodied by his teacher education instructors and summer institute peers provided this safe place.

Todd's Concerns

External Constraints

Todd perceived several constraints on his teaching external to himself. Prominent among them were the constraints imposed by administrative and legislative forces. Problems with students and their families, the attitudes of his peers, and the nature of the curriculum also caused Todd concern. These constraints forced Todd to modify his approach to teaching, conform in ways he did not want to, rebel at times, and may ultimately contribute to his leaving teaching.

Todd had difficulty dealing with the paperwork, supervisory duties (e.g., lunchroom and hall duties), and extracurricular responsibilities (e.g., coaching and sponsor duties). For example, these time constraints lead him to lower his expectations for planning his lessons. These pressures reached crisis proportions at several times during the year. Early in the year, Todd said he felt guilty about his lack of planning for instruction. Later in the year he said, "I don't feel guilty about that any more. . . . There's just no way I can keep up with it." Later Todd was neglecting some of his supervisory duties and "actually had administration leave a nice nasty note." He responded to these pressures by saying that his job was to teach and that he was not going to feel bad if he was not at his post in the hall because he was helping a student. Todd at times avoided his post in the hall, rebelling against assigned duties, and often complaining to his peers about these responsibilities. In some sense this attitude was again a safe place for Todd to stand, because his peers shared these sentiments leading in some cases to collective action against the administration.

Todd blamed the system as well. "You can try to interest [the students] in teaching, but they feel peer pressure from the rest of the class, since they've been

tracked, and they feel it's not cool, I guess, to be interested" (October 1993). Todd believed this tracking of students sets them up for failure. Students who had been unsuccessful in the past at mathematics were in the same classes without other students to be positive role models. Within these classes, the pressure from peers was to be uninterested and not to succeed. Todd thought these students should have been "mainstreamed" so they could have peers who succeed and thus be motivated to succeed themselves.

The last external constraint came to Todd through two vehicles. Todd felt constrained by (1) the traditional schooling emphases of his peers and (2) his curriculum. Todd believed his peers were satisfied with the status quo and afraid of change. This belief caused Todd to fear "stepping on toes" and thus he said he was trying to reform the instruction in the school in gradual steps. He seemed confident that over time he can have an effect.

The second vehicle, the curriculum, constrained his teaching because of the amount of basic skills he had to cover. This constraint was a part of an important tension that arose in Todd's thinking, which is described in the following section.

Todd's Continuing Growth

Trial and Error

During Todd's teacher education program, he was looking for the details for putting his ideas in action. He wanted to be a teacher that was able to get students interested and excited about mathematics. He wanted to show them mathematics was not boring and see them grow and develop. When he got "in the trenches" he found these ideas did not necessarily work. His idealism did not meet what he perceived as the reality of the classroom. Thus, learning what does work in the classroom has been a process of "trial and error." In general, teaching has not been what Todd had hoped, but has proved to be "more control, not teaching."

Todd used many of the ideas from his teacher education program, but especially struggled with his "lower motivation classes." He said, "I'm struggling now and I'm pretty much learning by trial and error. But I used several labs that were presented to me—and I can with those upper level classes. It's just those the lower motivational students that I have difficulty with" (April 1994). He described the process he went through with his "worse" class,

> I experimented. The first two weeks, I guess I went in kind of blindly, just trying to teach as I taught my upper level classes and that didn't work at all. It just became kind of chaos by the end of the second week. So then I started off being a little stricter, a little stricter, a little stricter and that didn't work. So we just went to all, total authoritarian type where they were to just sit in their desks and the first time they got out was detention, the second time they got out we had to go to the office, and then slowly give them a few chances at freedom. . . . After I had controlled them, we tried [an activity in which the students] race motorcycles and determine miles per hour and rates, but they couldn't handle that. And so I kind of was discouraged with that. I figured if it would be a little bit more interesting. It was just really frustrating. It's kind of like beating your head against a brick wall. (October 1993)

Todd thought that if these students were not tracked and thus had positive role models in the class they would be better motivated. Todd struggled with the best way to teach this type of class—a class full of students who have been unsuccessful in mathematics classes in the past and had no expectation or desire for success.

Todd Looking Ahead

As Todd looked ahead at his career he said, "I do like what I do, but I don't know if I have the patience to go through ten years of that." He hoped to continue to be a good teacher, trying new things and learning what works. He did, however, still plan to

return to engineering or educational technology, particularly in curriculum and courseware development. He said,

> I really enjoyed engineering and that's why I took all the math classes first, And I just found I really enjoyed teaching. I still, I'm considering going back towards engineering or educational instructional technology after getting an idea of more in the trenches. A lot of people call it being in the trenches, teaching in the classroom. [After getting an idea] of what are some good ways to start implementing some of these nice math skills using manipulatives and hands on material and applying things. And I know a lot of people, that's the current trend, a lot of people are really pushing for application. That's something that really interests me. I enjoy coming up with the ideas. That's another thing teaching allows me to be creative. I like being able to use my own creative thinking in the classroom. That's why I kind of think, I'm hoping to go back to [educational technology] using my own ideas maybe to see if I can implement them. (October 1993)

Todd wanted to be creative, use his own ideas, and design new curricula and, thus, be involved in the mathematics he found interesting without the constraints found in the classroom. Todd believed software development in educational technology would provide the opportunity for him to pursue these interests. Furthermore, he maintained this view throughout his inservice year.

ANALYSIS OF BELIEF SYSTEM

Belief System Structure

In Todd's preservice experience, four themes arose important to his thinking about mathematics and about teaching and learning mathematics. These themes represented four clusters of beliefs within an inferred quasi-logical organization (Green, 1971) of Todd's beliefs. The themes of *making mathematics interesting* and *problem solving* were evident in Todd's thinking from the beginning of his teacher education program.

The two themes of *structure and control* and *helping people* were less explicit during the preservice year, but became more important and explicit in Todd's thinking during the inservice year. The beginnings of conflict between these themes appeared as Todd entered into situations where he had to reconcile competing themes.

Connections and Conflicts in Todd's Belief System

Todd closely connected the themes of "making mathematics interesting" and "problem solving." Initially, ideas related to problem solving—reasoning, investigating, student freedom—constituted Todd's goals for the student in the mathematics classroom. Thus, "making mathematics interesting" was Todd's way of accomplishing these goals. Both of these clusters of beliefs came into conflict with the ideas of "helping students" and "control and structure." The failure of the students to be interested in the activities and failure to learn even if they were interested caused Todd to question these two areas of beliefs. Todd's beliefs that he had to explain the content to the students and to always be ready to provide them the next step in solving problems, both parts of his "helping" theme, were heightened and began to take precedence over interest and problem solving.

Todd's "helping" theme became more closely associated with his "control" theme. Difficulties in classroom management led Todd to take a more authoritarian role in the classroom and caused him to limit the students' activities. Todd conducted much more teacher-oriented classes than he had hoped. By the end of the year, he said that the students enjoyed more structure and experienced greater success when he was there to help. Todd seemed to feel he was in control of students' learning and, thus took more control over the classroom activity. He felt that the students most benefit from his individual attention, thus he was afraid he would not be as effective when he had less time after his marriage this summer.

Another aspect of the control theme was the controlling or constraining influences placed on him from outside the classroom. State requirements, expectations

of administrators, and the curriculum as represented by the book and the expectations of the teacher of the next class all led Todd to feel guilty early in the year as he was not able to live up to all of these expectations. Later in the year, Todd shifted to at least verbal rebellion against these controlling forces or found ways of circumventing their authority. For example, he circumvented the curriculum by getting his classes far enough ahead to be able have more control over what he did in class at the end of the semester.

Discussion of Belief System Transitions

The transitions that occurred over the Todd's first year of teaching were primarily related to the strength of commitment to the four core themes in Todd's belief structure. Before Todd started teaching, he emphasized the "making mathematics interesting," while, not surprisingly, during his teaching the theme of "control" overwhelmed the other themes. The theme of control also affected the definitions of the other themes becoming more central quasi-logically. For example, Todd had expected problem solving activities to be a central part of his teaching. The constraints of the curriculum and controlling students led to a redefinition of what this problem solving emphasis looks like in his classroom. Todd hoped the problem-solving skills the students developed doing problems of the day and bonus problems would transfer to the rest of their mathematics learning.

An alternative explanation of this shift is in terms of Scheffler's idea of "motivated blindness" (1968). During Todd's teacher education program, he began with an emphasis on applications of mathematics. These ideas were reinforced and enhanced by reform ideas presented in the teacher education program. Todd's concern for control and his feeling that he was important for students' learning were probably in place because of his extensive tutoring experience, but he had no outlet for or need to express these ideas during his teacher education. Thus, the peer pressure and pressure from authorities may have caused Todd to suppress his concern for control. Over the

course of the year, Todd at times raised the question of classroom control, but never received a satisfactory answer. Eventually control became less of an issue in his mind. That concern changed when he began teaching. This transition was not a gradual change over the course of the inservice school year, but a change Todd experienced over the first two months of school.

In terms of Green's (1971) spatial orientation or psychological commitment, at the beginning of the first year of teaching, the themes of "making mathematics interesting" and "problem solving" were most central followed by the themes of "helping people" and then "control." Later, the theme of "control" became more central and "making mathematics interesting" became less central as Todd saw interesting students as less realistic. In Todd's inferred quasi-logical structure of beliefs, at least partially isolated structures became connected. While the interest and problem solving themes began as core structures, control and structure themes became the core for his thinking about teaching.

Relation to Authority

For understanding Todd's orientation to authority, the transition between multiplism and relativism for Perry and a comparison of the positions of subjective knowing and procedural knowing for Belenky, Clinchy, Goldberger, and Tarule (1986) was essential. Four elements characteristic for this transition are:

- Recognition of alternative voices,
- Recognition of one's own voice,
- False openness, and
- Struggle with incorporation of other voices.

In the following discussion, I consider these elements based on Todd's thinking during his inservice year.

Recognition of his Own and Alternative Voices

Todd clearly recognized differing views about teaching and curriculum. In choosing the best text, computer, or calculator, Todd said "each person has their own individual views." This recognition along with his emphasis on students working problems using different methods indicated at least some level of multiplistic thinking (Perry, 1970). Although, he recognized different ways of thinking, Todd still seemed to believe in the existence of a right way to teach, thus holding views that fit Perry's stage of multiplism prelegitimate. Todd talked about receiving advice from other teachers but emphasized that he modified the advice to fit his beliefs. He often criticized the advice he gets. His evaluation of other people's views could be interpreted as the evaluation that takes place in Perry's stage of relativism, but he seemed to be judging the ideas in light of the more progressive educators of the day, those he viewed as the authorities. He saw himself as an agent of change in a conservative environment but without the standing to push this change.

In a sense, Todd was recognizing his own voice as in accord with the authority in education. Todd believed he had insight to contribute to reform. The environment he was in, however, limited his ability to express his ideas. Like Belenky et al.'s (1986) subjective knower, Todd subtly rejected the voices around him, depending on his own voice. He felt, however, he could not express that voice. He had to avoid "stepping on toes" and he had to have the experience "in the trenches" to gain the right to speak. Unfortunately, he did not feel that the others around him (i.e., in his school) would listen because they were afraid of change.

Todd's desire to enter the field of educational technology illustrated this state of subjective knowing. Belenky et al. (1986) said that the subjective knower often, after finding her own voice, becomes frustrated with the constraints of her circumstances (e.g., school) that hinder the expression of this inner voice. Todd believed that leaving the classroom would allow him to create and design courseware and activities that put

his ideas in practice. He would then be able to create and design without having the constraints of low motivation students, administrators, and uninteresting curriculum.

False Openness

Belenky et al. also said that while subjective knowers "professed to be open to anything, they were, in fact, stubbornly immune to other people's ideas" (1986, p. 98). This statement describes Todd well. He was not impolite or openly deceptive, but his own ideas were very important to him and he saw support for his ideas in his teacher education program and a summer institute for mathematics teachers he attended before he started teaching. In a sense, he was in the "in" group and wanted to help the others catch up. Unfortunately, he faced the others' fear of change. Consequently, Todd proceeded slowly. This description corresponded to the flip side of Perry's (1970) stage of relativism subordinate—multiplism coordinate—where the person takes advantage of multiplism. Todd exhibited some vestige of this as he "holds back" as a first year teacher so as not to "step on feet," but made moves he wanted to make slowly.

Thus, Todd recognized others' ideas but stubbornly adhered to his own. This stubbornness is characteristic of a subjective knower or someone in the stage of multiplicity coordinate. He also, however, seemed to be open to or beginning the transition to procedural knowledge. In this stage, one begins to deal with the issue of how to incorporate the ideas of others. A person who makes use of procedural knowledge tries to understand the context of situations and take others' voices into account in making decisions. Belenky et al. said this person is humbler than the subjective knower, not taking their own ideas as seriously, but incorporating outside voices. In some small sense, this description fits Todd. He was apologetic when he expressed his views strongly, especially when he contemplated pushing his ideas (e.g., not wanting to "step on toes"). He talked about being open to others' ideas (which Belenky et al., 1986, said a subjective knower may well do).

Incorporating Others' Voices

As Todd struggled with incorporating others' voices, he preferred a separate approach (Belenky et al., 1986). When dealing with students, he had limits to what he can help them with. He helped them with mathematics, but quickly let them know his legal responsibilities in counseling situations. Todd practiced a selective integration of voices based on his more primary beliefs, particularly the theme of "helping students." These outside voices he heard were the voices of administrators and the curriculum. He integrated these voices with his own in making decisions. Todd either showed a great respect for or deference to authority or, at times, a rebellion against authority. The rebellion came when he perceived authority's integration with his own voice as stifling his contribution. A clear example was when he said he would get in trouble for not performing a duty before he would let the duty interfere with his helping a student. This selective integration of the voice of authority and following rules in listening to others is evidence that Todd was only making the transition to procedural knowledge.

Conclusion

In Todd we meet a very conscientious person concerned about doing his job well and making a contribution both to the students' development and to the field of education on the level of his own school and district and more broadly. He experienced the natural struggle between the idealism of a preservice teacher and the realism of the classroom. During his teacher education program he held the somewhat disconnected ideas of making mathematics interesting for students, mathematics as problem solving, helping people, being in control or under control. Todd was looking to his teacher education program to provide him with the way of putting his ideas into practice. He saw the ideas he confronted as congruent with his existing ideas, only adding to them. He also found that his teacher education instructors were not as concerned with giving him information as much as helping him in his process of thinking and developing "his own ways." Moving into "the trenches" of teaching, he found conflict within his belief

structure forcing readjustment and redefinition. Todd struggled in the beginning of a transition to more relativistic thinking from multiplism (Perry, 1970) while clinging to and looking for the time when he could push his own ideas. As a subjective knower (Belenky et al., 1986) his own ideas were very important, especially as he perceived that he was part of the progressive group in education. Todd hoped in the future to continue to test his ideas, so he knows what works, and then to move into development of instructional technology, so he can pursue his own ideas, create, and design without the constraints of the school setting.

IMPLICATIONS FOR TEACHER EDUCATION

Many preservice teachers come to their teacher education programs seeking to be told how to teach and what to teach (Brown, Cooney, & Jones, 19). They have spent years being told what they need to know and do in school and they see the teacher education program as another stage of this telling. They can only conceive of being learners and receiving knowledge from an authority (cf. Perry's dualistic and early multiplistic stages and Belenky et al.'s position of received knower). As one of Ball's (1988) participants said after a field experience, "One thing I learned from this experience is that I am not qualified to teach math yet. Once I have the math methods class, then I will be much more ready" (p. 46). Nancy and Sally in Shealy, Arvold, Zheng, and Cooney (1994) express similar sentiments toward their methods courses. Within the teacher education program, their beliefs often face few constraints, are left unchallenged, and consequently remain unchanged. Typically, the teachers assimilate information without accommodation.

Todd, for example, investigated mathematics in the context of problem-solving situations in a course on problem solving. He participated in open-ended investigations in other mathematics education courses in the context of learning to use technological tools. Todd saw these investigations as enforcing his emphasis on making mathematics interesting and providing him the details of accomplishing this goal in his classroom.

He never faced the difficulty of interesting students in the classroom. Many teachers' experiences, like those of Todd, are not new in the sense that they do not encounter situations that their mental structures can not assimilate. They do not have to challenge their beliefs—that is, make them explicit, or as von Glasersfeld (1991) defines reflection, "step out of the stream of direct experience, to re-present a chunk of it, and look at it as though it were direct experience, while remain aware if the fact that it is not" (p. 47).

It seems reasonable to assume that Todd is typical of many preservice teachers who have isolated substructures of beliefs. The preservice teachers' experience with teaching and learning have been in isolated contexts. The different situations teachers find themselves in will trigger the use of different substructures as they organize their experiences. For example, Todd's themes of *making mathematics interesting* and *problem solving* might represent his structure of conceptions about his doing mathematics. Within the teacher education courses, he never left the context of *his* doing mathematics. His experiences never triggered in any substantial way the structures underlying his themes of *helping students* and *control*. Placed in the context of the classroom, Todd's belief structures related to teaching directed his thinking. Changes within these pedagogical belief structures cause teachers to experience internal structural conflict. This conflict forces re-evaluation and redefinition of themes and connections within and between belief structures. When preservice teachers experience the conflict of belief substructures, they may reject or redefine their understanding of what they learned during their teacher education program.

Isolated substructures of beliefs arise because of the compartmentalization of experience, that is, making implicit distinctions in experience. In the process of developing one's orientation to a set of experiences, categorization of experience simplifies and facilitates the adapting process. Preservice teachers have learned about the actions of teachers through observation. They have learned about mathematics and the actions of students through their own activity. When two or more belief

subsystems, as in the case of Todd, come into conflict for the first time in the first year of teaching, the teacher needs to find a construct or set of constructs that alleviate this conflict (cf. Maturana's, 1978, idea of avoiding loss of identity). For many teachers the subsystems that take precedence will be those related to their own school experience. In the teacher education program, these teachers need experiences that make these subsystems evident and lead the teacher into a reflective and critical analysis of their own thought processes.

Todd provides a case that seems representative of many people beginning their careers as teachers. Further studies of cases different from Todd should provide important insight into the process of learning to teach, especially how the cognitive structure of the individual affects this process. A teacher educator may see teachers without the well-defined substructures of Todd who are dependent on external authority for their development (e.g., Nancy, Sally, and Henry in Shealy et al., 1994). Alternatively, teachers who have already worked through inconsistencies in their beliefs and see knowledge as contextual may come to the teacher education program (e.g., Greg in Shealy, 1994). Each of these cases may contribute to a framework for understanding the teacher development process.

POSTSCRIPT

As Todd completed his first inservice year, he called me to tell me he had been named "Teacher of the Year" at his school. I thought about this news in light of the analysis of Todd presented above. Todd devoted long hours to helping his students. He was continually concerned about growth in his own mathematical and professional knowledge. Todd accepted and performed the extra-curricular responsibilities he was given by his administrators. His administration saw him as a model teacher. As a teacher educator can I ask for anything more? A good question.

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