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AUTHOR Tuan, Hsiao-lin; LaRussa, Annette
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ABSTRACT

Research in teacher education has shifted from an emphasis on teachers' behaviors to a focus on teachers' thinking. The purposes of this paper are to describe categories of beliefs held by preservice secondary science teachers, to describe how the preservice teachers planned lessons, and to discuss the influence of their beliefs on their planning. This paper draws on data from two studies of preservice teacher education. The informants for these studies were five preservice teachers enrolled in secondary science education. Data collection consisted of semi-structured, open-ended interviews, observations, and lesson plans written by the informants. The findings from both studies indicated that preservice teachers shared many common beliefs, possibly reflecting the influence of the education classes. Most teachers placed importance on science processes and valued understanding over memorization of facts. The findings support the contention that beliefs are a dominant factor in influencing teachers' planning and that teacher educators may influence previous teachers' developing beliefs, or reinforce existing beliefs. It was recommended that science educators promote self-reflection among preservice science teachers. (CW)

The Influence of Preservice Secondary Science Teachers' Beliefs on Their Planning

Hsiao-lin Tuan
Annette LaRussa

University of Georgia
Science Education Department

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the National Association for Research in Science Teaching,
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Introduction

In the past decade, research in teacher education has shifted from an emphasis on teachers' behaviors to a focus on teachers' thinking. This change in focus reflects a growing recognition of teachers as thoughtful professionals and an awareness that behaviors grow out of thinking. Clark and Peterson (1986), in a review of research on teacher thinking, identified topics such as teachers' beliefs and teachers' planning as areas of needed research. Researchers of teacher thinking have identified teachers' beliefs as having a powerful influence on their decision-making while teaching (Shavelson, Cadwell, & Izu, 1977)

. Another component of teachers' cognition, their planning, has traditionally received the attention of educational researchers. Educators can make a compelling argument that good planning is necessary for good teaching. However, most researchers investigating how teachers plan have relied heavily on surveys (Yinger, 1977; Taylors, 1970). While this provides general information about the kinds of planning engaged in by many teachers, it tells little about the concrete details of day-to-day planning or about the facts influencing planning. Additionally, research on teachers' beliefs and teachers' planning has tended to focus on practicing elementary teachers or practicing secondary science and math teachers. Few studies have focused on preservice teachers' beliefs, planning, or the

influence of their beliefs on their planning.

Purpose

The purposes of this paper are to describe how the preservice teachers in our studies planned their lessons, and to discuss the influence of their beliefs on their planning.

Design and Procedures

This paper draws on data from two studies of preservice teacher education. The first study was conducted winter and spring quarters, 1987-1988 and was designed to investigate the influence of preservice teachers' beliefs and subject-matter knowledge on their planning. The second study was conducted throughout the 1988-1989 academic year. The study was an exploratory study investigating preservice teachers' perceptions of their own experiences in the preservice secondary science education program at the same southeastern university. The informants for these studies were preservice teachers enrolled in the secondary science education program.

Both studies employed a qualitative research design (Bogdan and Biklin, 1982). In the first study (Tuan), data collection consisted of semi-structured, open-ended interviews, observations, and lesson plans written by the informants. Each of the three key informants were interviewed four times winter quarter and video tapes of their microteaching were observed twice during their practicum placements. The researcher observed and interviewed these same informants approximately once a week during student teaching. The researcher also took notes during

methods classes winter quarter, post-observational supervisory conferences spring quarter, and the student teaching seminars spring quarter. Each informant was interviewed by the researcher at the end of student teaching. All interviews were audio-taped and transcribed verbatim.

In the second study (LaRussa), data collection consisted of writing field notes during science education classes fall and winter quarters; interviewing key informants (3 to 5 preservice teachers) on a weekly or biweekly basis throughout the year; writing field notes during observations of microteaching and student teaching lessons; and collecting documents, such as lesson plans, journals, and university science education assignments, written by the key informants. Interviews were semi-structured and open-ended. Field notes were written during interviews and most interviews were audio-recorded.

In both studies, data analysis was inductive and comparative. Initial categories were generated using the method of open coding described by Strauss (1987). All available data was used to refine these categories. Data analysis is still in progress for the second study (LaRussa). The findings reported in this paper reflect the findings of Tuan's study and preliminary related findings from LaRussa's study.

Subjects

At the time of the first study, Tina was a 23 year-old female in her senior year of college. She attended two different colleges before transferring to this university. She changed her

major from industrial engineering to chemistry, and finally, to secondary science education.

Chuck was a 24 year-old male graduate student. He had been in Forestry School for five years and obtained a bachelor degree in Forest-Hydrology. Two years before this study began, Chuck decided to become a science teacher. Originally, he wanted to be a biology teacher. However, Chuck took many courses in Geology instead of biology, therefore, he was working on his certification in geology-earth science in this program.

Sally, a 35 year-old female graduate student, had completed her undergraduate degree in Zoology eleven years before entering preservice teacher education. At the time of this study, she was married with two children. In the time between the completion of her bachelors degree and entering preservice teacher education, Sally worked in a number of jobs including working as a lab technician and as a consultant in training people to use equipment. In the year immediate preceding entry into the preservice teacher education program, she taught first and second grades in an elementary school. Sally's decision to pursue teaching as career reflects her belief that teaching is compatible with her roles as a wife and a mother.

Sean was in his early thirties when he entered the teacher education program. His undergraduate degree was in biology and he completed several graduate level microbiology classes while employed as a technician in a university research lab. As a technician, Sean was accustomed to assuming responsibility on

important projects, including heading a project on which he reported to the World Health Organization. Sean enjoyed music and dancing very much. He taught clogging and was a square dance caller.

Kay was in her late twenties when she returned to college to complete her undergraduate degree in science education. Kay had no experience in either science or teaching. However, she loved science classes in school, particularly those relating to human anatomy and physiology. She, initially, planned to teach biology although, by the end of student teaching, she also was interested in teaching physical science.

Setting

During winter quarter each year, the teacher education students were required to participate in an early field experience referred to as the practicum. During this practicum, each informant taught two, two or three day science lessons, one to high school students and one to middle school students. Student teaching occurred spring quarter each year.

During student teaching Tina taught one average seventh grade math class, one physics class, and two chemistry classes at a rural county high school. Chuck taught eighth grade earth science classes at a rural county middle school. Sally taught several topics such as basic biology, advanced biology, ecology, and earth science in a rural high school. Sean taught basic ninth grade physical science and general biology at an urban high school. Kay taught ninth grade physical science and advanced

biology at a rural high school.

Findings

Planning (1987-88)

Tina. Planning meant several things to Tina, including lesson planning, unit planning, and weekly planning. Whenever Tina planned a lesson, it always consisted of both mentally and physically planning for classroom teaching.

Tina's lesson planning consisted of reading and doing research. Her planning procedures were task-oriented. She first thought about the topic then planned how to begin the lesson. She then selected activities to incorporate into the lesson. Then she planned how to summarize and elaborate the findings. In her planning, Tina was primarily concerned with her own actions rather than considering her students' needs. The following excerpt from an interview with Tina illustrates Tina's view of her own planning.

> I: When you planned your lessons, what did you consider of the things that you have learned from the program?
> T: I don't think, maybe unconsciously I do, but when I start writing my lesson, it just comes out right of my head. I don't sit and go what should I do, why shouldn't I do that, why should I do this and not do that. I don't do things that way. I just go this is what I have to tell them, here is what I am going to say, here is how I am going to do it.

When Tina wrote her first lesson plan during the practicu ., she was very specific in writing down exactly what she would say to the students. An example of the specific detail in her

planning is as follows: "Let's go to the lab; let's put on our glasses; let's do this." After getting some teaching experience, Tina only wrote down the key points (such as definitions) she wanted to cover. Usually the key points referred to the definitions of new terms. She did not like to write objectives because she considered objectives to be useless in her planning and a waste of time.

Tina heavily relied on the structure provided by the student textbook in her planning and used outside resources to reinforce this basic structure. Resources that she collected to aid in her planning included journal articles, newspapers articles, college textbooks, and high school textbooks. In searching for useful resources, Tina looked for hands-on activities, questions, and science content. Having varied resources that she could draw on in her planning lent Tina confidence in her teaching. Tina described these resources in the following interview excerpt.

> I: What do you mean about 'outside sources' when you were planning ?
> T: Well, like teacher's guides, or works. I go to the library and look for stuff, also. Umm, then from that I get questions to ask them in class or take home. Umm, mostly I get the problem from the textbook. Well, that is not true, I get them from other books, and either I have those for homework or in class or both, and also from outside sources, we get activities, we had activities and the activities are searched for materials, and I research the location of the materials and the safety, and to use the textbook and outside sources I write out the speaking part, that is it.

During Tina's student teaching, she taught one math class and two chemistry classes. In math classes, she viewed planning as designing some problems for students to solve. In chemistry class, students did frequent lab activities. Since Tina was required to follow cooperating teacher's teaching pattern, she felt that no preparation was needed for lab beyond setting up equipment before each lab session. As she said:

> It's just all lab all week and I loved that part. I was so happy when he let me teach that part. Plus you don't have to write up anything. You don't have to write lesson plans for it because you're not going to teach. You just have to observe them do the lab and help them out and stuff and I like that part.

Tina's area of specialty was chemistry. When planning chemistry lessons with which she was familiar, Tina began by refreshing her subject-matter knowledge so that she could think about the kinds of difficult science concepts students may have and then think about how to help students learn these topics. As she said:

> When I prepare my lesson, now I have three books on chemistry, two books on physics, and two books on chemistry II. So, I draw from those. It helps a lot. Because a lot of times, the kids have to use unclear concepts. I think it help me in a way to have relearned things. Because then I can be ...I can look at it from learner's point of view, instead of always from the teacher's point of view.

Chuck. Chuck's planning, as he described it, followed a certain procedure. He read the topics; he took notes; he thought about the procedures needed to present the lesson; then, he

developed questions to ask the students. When Chuck designed questions, he not only thought about the kinds of questions he would ask, but also predicted students' responses to the questions. When I asked him about the notes he wrote before the class, he explained:

> C: It depends on how much time I have - when I do a good lesson plan, I go through and I read what I am going to need, what the topic is and my procedure that is to generate notes on what I am going to talk about. After that I write a page of questions - if I do it right I'll have the procedure and the questions lined together - for this procedure there will be this number of questions . . . and I'll try to ask those questions.

Chuck is creative and willing-to-try. When he planned a lesson, he spent a lot of time reading the materials made for the students and designing student activities for the classroom. In the following example, Chuck describes the resources he uses in designing lessons.

> For lesson plan, I use . . . lesson plan, for what I was going to do, I just make up myself. I try to stay away from lecturing, and just giving terms giving them that. I kind of came up with my own activity. I'll have not been able to think an activity, I will go to looking for some. The way happened was that I just came up with an idea, and then decided to try out that idea.

Resources Chuck uses in planning lessons include his own college textbooks, cooperating teacher's advice, high school textbooks, and, most importantly, his own creativity.

> I: How did you start this lesson, and where did you get the material to plan this lesson, which is not your favorite?
> C: From the textbook. I just read the

textbook.
I: Where did you find the crossword puzzle?
C: I designed it by myself based on the terminology from the high school textbook.
I: How about the lab activity?
C: My teacher suggested it to me and I think that was a good lab activity.

As a student teacher, Chuck was not only a creative, but was also willing to try and learn. Whenever he planned his lesson, he would try to incorporate what he learned from his university methods class, such as objectives, evaluation, etc. into his planning. He used these strategies learned from the methods course to help him check his own planning. The following is an interview excerpt in which Chuck described his planning.

> I didn't have everything . . . application I didn't really have and I don't know if I really have a synthesis but I wanted to make sure that I have more than just knowledge -- make sure that I have analysis, and evaluation . . formulate questions . . . add process to me to what I was doing that wasn't just knowledge . . . That I have other things in there so . . . What I did was I knew what I wanted to do - and then I wrote my objectives but I wrote my procedures before I wrote my objectives - so I think I formed my procedures and add to my objectives.

Chuck was a very creative person but he had a lot of trouble organizing his ideas and was very concerned about his organizational skills. Other concerns he expressed in planning lessons included the flow of the lesson, the interest level of the lesson, and having enough materials to fill the time period.

> Organization is a problem for me. It's not like I don't work at this. - I get 4/5 hours of sleep at night. - I work at it every day but I need to work up some organizational structures, to regularize things that I do to make things flow more smoothly.

> I worried about having filled up the entire time and about keeping things smoothly. Keeping it interesting. I worried about being prepared, knowing what to do next. I do not feel that I had that in here, and I do not know if I need a lot more than I have or not.

Sally. For Sally, planning included lesson planning, daily planning, and unit planning. Whenever Sally designed her unit plan, she would outline the topics to be covered each day. She then designed assignments and searched for materials which could be used in teaching these topics. As she said:

> I have a general lesson plan I have set up for the second and fourth for the next three chapters for the next three weeks and I'll just outline what I'll do such as topic for the day, homework assignment. I have . . . get all my stuff together that I need to photocopy off.

Sally's daily plan was very detailed in describing the procedures step by step in order to finish certain tasks in certain period of time. In the following example, Sally explained what she needed to accomplish in the class.

> In the third period, we will finish - talk about monocots and dicots a little more. . . and I brought in plants. We will talk about terms like evergreens, deciduous about 10 minutes - 5 minutes and then I am going to have them break up into groups and try to and classify some plants - just say that is a monocotyledon, which is a dicotyledon - perennial, annual, that kind of stuff. . . so that they can use the terms and think of plants in those terms. The second and fourth periods will to finish taking grades. - Probably had the grades taken and finish up the chapter,- answer the questions and things and then Monday we will review that for test Tuesday. That is what we will do.

Unlike Tina who used mental planning all the time, Sally liked to write down whatever she was thinking in her planning in order to help her remember all the ideas and information she needed to teach.

> I have been thinking about them several days. When I thought of something I wrote it down a list in my car - that type of stuff - just like on the way home or something.

When Sally was doing her lesson plan, she studied through the chapter in order to become familiar with the content, and also to find out what students needed to know. This is the first time Sally taught a middle school class. Therefore, Sally relied heavily on the structure of the content in the textbook. She used activities from outside sources to supplement the material in the student textbook.

Sally perceived herself as a "pro-activity" type teacher, because she liked to include many activities in her lessons. She used ideas from her methods class, the cooperating teacher, and various textbooks to plan activities. She spent a lot of time in searching for activities and preparing all the materials needed to be used for those activities. Two examples are listed below to describe how Sally prepared her lessons:

> For the lab what I do, just based on textbook and I had borrowed about four chemistry books from Ms. X to pick up something interesting facts stuff. Then I check about three or four library books on water quality, it is really discussing thought which treatments, things like that. For the class today, we did things on acid rain, and I checked about 14 library books for the class to use the things looks good. Then look at some biology books, stuff like that.

> In the last week I started trying to get ome moldy bread and moldy cheese and planted some moldy onions. I started trying to get those to become more moldy and stuck them in the warm spots in the house. So I have been thinking about this since last week and then I made . . . cards on fungus.

Sally likes to incorporate variety of teaching methods in her planning, such as short lecture, short activities, and class discussion. In addition to activities, Sally also liked to plan small stories, or find interesting information to attract the students' attention in learning. These stories and interesting facts came from her own experience or from books she had studied.

> So, no matter what I am teaching, it has been so long since I have been in school, I always read abundantly on it, find other materials, old textbooks, whenever, I always read before me teach, and take notes, and because of that, I often come up with unusual information that I can give to the kids to make them be interested.

> I usually try to get some information from other places than the textbooks. I usually try to get the interesting information such as 'did you know' type of stuff because I find that interesting myself.

As mentioned before, this is the first time Sally had taught middle school. Therefore, she wanted to be familiar with the whole spectrum of knowledge which students needed to know in order for her to teach. She read textbooks from the middle school level up to college level to obtain a holistic picture of science curriculum.

> So, based my own . . . In teaching, I tended to look the whole spectrum of the teaching, middle school, high school, and college, because the kids are were 8th, 9th graders.

Reading science textbooks not only helped Sally gain an awareness of science curriculum, but also helped clarify her understanding about the content she was teaching. Sally studied diligently so that she would be well-prepared for class discussions.

To plan a short lecture, Sally would go through the high school textbooks and try to break the content into small segments to teach. She also tried to identify the starting and ending points of the content she was planning to teach and to categorize the content into a simple form for the students to grasp.

> I think being a new teacher, it is easier and helpful to depend on the textbook. It's easier because things are right there in front of you know that you won't forget to cover the . . . or you may completely forget to cover leaves. It makes it easier in that sense - makes it easier to present information that needs to be known and the kids also can read just if you discuss something poorly and not explain it - they can read it in the book.
>
> The first thing I consider was how they wouldn't get confused - try to do it where everything was categorized - a little bit easier. It's a very confusing chapter.

Sally was very concerned about students' involvement and time in her planning. Sally believed being involved can maintain students' interests in learning. Therefore, Sally tried to incorporate students' ideas into her planning. As she said:

> I think planning involves not only that you are going to do in the class, but how much time you have to do. You always have to think in terms of what will you accomplish in the class, what is your students can do in the class.

Sally was also concerned with time management in her planning. Sally tried to find the starting and ending points in the lesson in order to finish the lesson on time. In spite of the care she took to manage time effectively, her inexperience in judging the time needed resulted in Sally's having to make several immediate decisions in order to finish her long-term plan. In the following example, Sally described how she handled the daily lesson plan.

> Well, I am thinking about it today. I will work on tonight and I am going to talk to coach (cooperating teacher) tomorrow. The thing is we are doing some project type of things for both classes, so I don't real know what we can do for Monday. It depends on what they do today and tomorrow.

Interaction between planning and beliefs

Tina. Tina's planning was influenced by her beliefs in some ways. Examples include the following: (1) She planned to use a variety of teaching techniques to promote student interests; (2) She planned to use work-sheets for individual work.

Each of these examples relate beliefs Tina had to teaching. In particular, she believed that the teacher is responsible for maintaining students' interests in learning. For this reason, she planned to use a variety of teaching methods. She also believed that work-sheets were instrumental in promoting the learning of individual students. Therefore, she planned to use these in her teaching. The examples are as follows:

> When she planned a lesson on radio-activity during her practicum, she said: I decided that I was not going to lecture all day on

> radio-active elements, because they are real hard to understand for one thing, and they are boring. So, that is why I picked the part of seemingly accidental things like that. They will have to relate today's more. Because that is interesting. Because you can have something to say about that even you do not know anything.
>
> I: How did you plan for chemistry class ?
> T: I sort of planned to do a work sheet today but TPAI just got in the way. I just didn't have any time to put one together. But I like work sheets and I would do one for them, and I plan to do one for them on the next section that we are going to do.

Chuck. Chuck believed that teachers should try to maintain students' interest in learning. This belief was reflected in his planning when he tried to incorporate activities, interesting information, or stories, etc. into his lesson plans, so that the lesson would be interested to students. One example is as follows:

> I: What are you going to do on this chapter?
> C: This chapter 7 (weather). This is all basic stuff. I am trying to make it a little bit more involved like this, I am trying to bring in something on the nature of science today if I find something if I have time . . . if I can find something, I may try to bring that in and Friday I was thinking of showing a good video on weather. I have a good video that the school has and I got some stuff from my resource unit.

Other beliefs that were reflected in his planning, include beliefs that students learn best from group activities and from their own experiences and that students should take responsibility for their own learning. These beliefs were intertwined in Chuck's planning. For instance, he planned many

activities for students complete individually to be followed by group discussion to enhance their learning. Chuck hoped that students could learn independently from experiencing these activities. In his description of one lesson he planned to teach, Chuck said,

> I will put them (students) into groups and within the group each person would have a designated task so that in that way as much as possible to get everybody involved in the activity and hopefully they are going to have a good discussion on what's going on, what they have seen happen this week and they are going to be. Hopefully they are going to understand better what all these independent data means.

Conceptual learning was also important to Chuck. In his lesson plans, Chuck included many examples to explain the concepts to the students instead of requiring students to memorize these concepts without understanding. Chuck's belief in the importance of conceptual learning is reflected in a comment he made explaining how he would like his teaching to differ from his cooperating teacher's during the practicum.

> I think I am going to try to use the terms to show the processes, to show to associate, not just have these terms but to associate the terms with something. We are doing lung capacity -- you have residual air in when you breathe out - you have some air left in - tidal volume that is normal breathing in - then you have tidal capacity that is the total amount of air that you can breathe in at once and then I am going to try use balloons to show and have them breathe-just kind of seeing something real - to be doing something and I am not going to sit up and draw on the board -try to get them tell me their own definitions of those terms.

Chuck believed that students need to know that science is tentative truth. This belief is reflected in one of his lessons, the purpose of which was to help students develop analytic thinking skills through reading scientific articles.

> Nature of science . . I probably would talk about it a little bit tomorrow or not tomorrow. I'll get it back tomorrow and I'll grade it and talk about it - see what they came up with-but I was just trying to do a little the nature of science-different people made different observations . . . that would help. You can't just accept somebody's measurements, their ideas and such without questions.

Sally. Sally's planning was influenced by her beliefs in many ways. Sally believed that all content presented in class needs to be applicable to students. Therefore, she revised the content to include applications. For instance, when Sally planned a lesson on the plant kingdom, she revised the lesson from teaching terminology only to focus on practical applications.

> Third period - because there is so much material in the chapter - because it's a survey of the plant kingdom. I wanted to make it a little more applied and I want them to do the . . . instead of just looking at pictures and labeling plant stems and plant roots, so I, kind of took it from the more practical stand point - things I am more interested in, too.

Sally believed that making things interesting and keeping students involved are ways to promote learning. Therefore, she planned a variety of hands-on activities and lab discussions in

her lessons, in order to maintain students' involvement and interest in learning. Explaining her approach to promoting students' interest, Sally said,

> Well, that is one reason that I, kind of took this approach to these chapters to try to and at least get them interested to start with. So, it is more interesting than to come in and say "Well, plants have roots, stems and leaves. We use plants for food."
>
> What I can do to make it interesting? You have to present knowledge. But you can present it in different ways. Sometimes you can think of a way to make it a little bit more interesting and I try to do it - I don't always succeed but I try to think of different ways to help the kids be interested in the stuff and learn something.

In summary, each of three informants discussed above believed in the importance of promoting students' interest in science content. This was reflected in their planning through the use of activities, interesting facts or stories, and using multiple teaching methods. Other beliefs about science teaching included beliefs that science content should be applicable to the students, that the teacher should promote conceptual learning over memorization, that students learn best when they are actively involved with the content, and that working in small groups can result in more learning than working exclusively independently.

Beliefs and Planning (1988-1989)

In my study (LaRussa), planning was not an explicit focus of the study. However, before each practicum lesson, I held an interview/pre-supervisory conference with each informant to

explicitly discuss his or her planning. Less formal conversations occurred with each informant throughout student teaching. This data together with numerous interviews in which the preservice teachers discussed their beliefs about teaching, their experiences in the teacher preparation program, their opinions of the teaching they observed during field experiences, their evaluations of their own teaching, and my observations of their teaching provides information on how their beliefs were reflected in their planning. In this section I will discuss Sean's and Kay's beliefs about teaching and the influence these beliefs seemed to have on their lesson planning.

Sean. Sean, like most of the other teacher education students in this program, was opposed to excessive lecturing, believing that students should be active in their own learning. The following excerpts are from an interview in October in which Sean explains his perspective on good science teaching.

> I: So, how would you teach, or how would anybody teach, to get away from saying, "Well, here are the facts and this is the way it is"?
>
> Sean: I think you need to start off with more of that inquiry type teaching - present the problem to them and then get several different ideas going as to how you might go about solving it. Maybe if nobody in the class can say, "Oh, that must be wrong," you might suggest some reason why one of their other ideas might be even better and go off on that lead. And, by the time the end of the class [comes], they'd have been going around in circles for a while trying to resolve it.

Sean was strongly opposed to having students memorize large bodies of factual information which was not required. This was

reflected in his own planning and in his reactions to his cooperating teacher's instruction.

> I: What do you want students to have learned?
> S: The curriculum guide only had one thing in it about fresh water: understand fresh water and what it meant to use it. I'd like them to know where fresh water comes from. I'd like them to have a general idea about the water cycle. I do not care about technical terms.

When his cooperating teacher required memorization of parts of a classification scheme, Sean became very angry. He knew that memorization of this information was not required by the state or local curriculum guide. In explaining his feelings Sean exclaimed,

> I had made science alive and here I saw it dying in front of me. It was going back onto the pages of the book. It is not required that they know those phyla!

In describing good science teaching, Sean believed that it was best to begin with concepts which were less abstract. Later more abstract concepts could be introduced if they related to earlier concepts. He contrasted the atmosphere with the human body. To clarify, I asked which of these two was more abstract. Sean replied:

> The atmosphere - Talk about the ozone. Who has seen ozone? But a lot of people have seen a hand before. ... So, if you talk about some things that might be related to it first, it's alright, but sometimes you just start talking about something that really isn't related to something you've been talking about and then it's kind of - You have to search for some way of giving them a feel for the idea.

Sean found science fascinating and believed that he could

teach science in such a way that students would also be interested.

> I had a pretty good experience in microbiology and bacteriology type courses. It's something that fascinates a lot of people - looking under the microscope. I was never interested in the microscope until I looked at a drop of water under there. Then you see all that and you wonder what's going on. there's a lot of directions you can go from there.

To interest students in learning science, Sean not only believed that the teacher must attempt to find interesting ways to introduce science content, he also believed the teacher must find a way to demonstrate interest in the students. He viewed his interest in music and dance as a way to relate to his students.

> Well, first you have to step out of your little lecture routine and find out what they're interested in. I mean there's some things that, as a rule, high school age students are going to be interested in. You can talk about certain music groups and relate it to songs they know, if you bother to listen to their songs. I think you have to force yourself to do some of that. ... If you talk to them some, you can find out what their interest is pretty quick. If you leave it sort of open. Don't just talk about page 4 of the textbook. Then once you find out what they're interested in, you can think about how you could put the material and relate that somehow to what they're interested in. I think that would be the big first step to show them that science is something that has to do with them now and in the future.

Of all the informants in my study, Sean had the most detailed, and the most concrete, planning. He planned in great detail, first identifying objectives in the state (or school) curriculum. He interpreted these, usually vague, statements at face value. He then developed an overall goal for the particular

required topic which reflected his beliefs about science and science teaching. He planned very specific objectives which supported his goal and planned activities and evaluations for each objective. While all teacher education students were required to include these components in their planning, Sean was unique among my informants in that he did not perceive detailed planning to be burdensome but often went beyond what was required. In pre-observation conferences in both the practicum and student teaching, Sean's explanation of his planning included a detailed, step-by-step description of what he planned to do, including alternatives to allow flexibility in decision-making during thee lesson. His descriptions of his anticipated actions were peppered with explanations of how he expected students to respond to his questions or benaviors, how he would respond to their predicted behaviors, and what he wanted students to learn from each part of the lesson and from the lesson as a whole. Sean also stated which aspects of a topic he considered to be unimportant. The following excerpt from my field notes illustrates the detail with which Sean planned and his concern with relating the content to the students lives.

> We're beginning a new topic. We had a test today on climate. We will take up fresh water. We'll discuss, I won't tell them much. Where is water? How much is there? Not percentages, just generally where do you find the most. What really is fresh?
>
> The EPA folks laughed when I asked them what fresh water was. Some say there's no such thing as fresh. Some say it's all fresh. It just depends on how you define it.
>
> We'll look at fresh bread. I'll ask them: "What is fresh?" I hope they'll say, "New." I'll tell them

the dinosaurs drank the same water you do.

Sean relied less on the students' textbook in planning than on his prior knowledge and outside resources. When planning a biology unit during student teaching, Sean checked out a number of books from the university library with pictures of the micro-organisms the students were studying. These were made available to students who asked questions during activities. Sean also utilized local community resources. In addition to checking out books from the university library, Sean checked out equipment from the science education department and consulted local businesses and agencies. For instance, in the fresh water example, Sean had contacted the Environmental Protection Agency. For the same unit, he had also contacted a local plumbing and well supply company. Additionally, he asked other students in science education for activities and was willing to share ideas with them.

In planning a lesson, or set of lessons, Sean planned holistically rather than sequentially. While he started with general goals and objectives, he formulated activities and evaluation items while still revising his objectives. He described this process in a methods class discussion as follows:

> One thing that helped me was, after I wrote objectives and goals, to stop and, not write a test, but a puzzle or worksheet and say, "What's on this?" I'd compare it to the objectives and add to one, subtract form the other."

As reflected in this example, Sean's concern with capturing students' interest in learning extended to how he planned to

evaluate students. One technique Sean employed was tying the content to the students' lives.

> They will look at maps of _____ County and find their house - see where their water comes from, if they do not already know.

Sean also planned attention-getters in his lessons which, in one case, he referred to as "outrageous." His attempts at capturing students' interest included wearing a cone head cap during his introduction to the fresh water lesson, including cartoons with a science slant during introductions, and designing worksheets which included puzzles.

Another influence on his planning, was Sean's evaluation of earlier lessons. For instance, during his high school practicum, Sean asked students to write cartoons as a class activity and then to share their cartoons with the class. One student was embarrassed to read the cartoon. Sean regretted this and in a future lesson, during student teaching, asked students to write short stories but did not ask students to read them aloud in class. He explained that this directly reflected the earlier experience in which students were embarrassed to read their work aloud.

Kay. Like Sean, Kay readily accepted the philosophy of science teaching promoted in the secondary science education classes. For Kay, this meant that ideal science teaching was non-traditional science teaching. Such science classes were activity oriented with the students taking responsibility for their own learning and the teacher acting as a facilitator of

their learning. The following excerpts are from an interview in the fall of 1988.

> I: What is the best way for students to learn science?
>
> Kay: By doing it. Not just by hearing somebody talk about it but by looking at it and participating in it.
>
> ...
>
> I: In the ideal science classroom, what would the teacher be doing?
>
> Kay: Going around and helping the students with what they're involved in. Not necessarily standing at the front of the classroom and lecturing all the time.
>
> I: What would the students be doing?
>
> Kay: Experiments and lab work of some kind and the teacher not really telling them, "You're doing this wrong. This is the way it should be" but to encourage them with what they are doing or maybe show them another way or other things they can do.
>
> ...
>
> Kay: What we've talked about in class - The traditional rooms and the traditional ways is - just doesn't sound very good to any of us andy more. ... We talk about you moving around the class and letting the class do things again - activities and dissections and whatever. They would be in small groups. ... You could give each of them a certain topic to investigate in some way. ... wouldn't necessarily have to be standing in the front of the room - walking around.

Kay was primarily interested in human anatomy and physiology and assumed the students would be as well because: "It's about them or how their body works."

When Kay planned lessons, she focused on the content and on designing activities. Her lesson plans consisted of a unit heading, a topic, a short paragraph describing the content, a short paragraph describing the activities for each day,

objectives, and evaluation items. Unlike Sean, she was not able to anticipate student responses or behaviors. Consequently, she was unable to plan alternatives based on student responses. Perhaps as a result of this, Kay was not very proficient when planning lectures during her practicum. She was unable to predict the length of time she would need to present a body of information. During the practicum, she completed her first lecture before the end of class and was unable to plan on her feet. Later, she reported that she was dissatisfied with her lesson. However, she was not able to clearly articulate why she was dissatisfied. She explained, "I basically did the same as _ __ [her cooperating teacher] and I don't really like the way she does things."

Kay planned student centered lessons in far more detail and with greater success. She preferred preparing for these lessons because they were consistent with her beliefs that students learn best when actively involved. To plan activities for these lessons, Kay went to outside resources including books of science activities, resources in the science education department, and science education students and faculty. She occasionally brought in activities or other resources to share with the other teacher education students. When planning student-centered lessons, Kay used outside resources as guides, generating parts of the lesson herself. For instance, when planning an activity on contour maps, she explained:

> I got a book from the library. The questions are not good. I'm making up my own questions. [For example],

Which side of the mountain is easier to climb?

Unfortunately, during student teaching, Kay was required to use a very structured lecture approach to teaching which was favored by her cooperating teacher. She initially planned variations on this such as planning a jeopardy game, in which she wrote all the questions, to review for a test on plants. The test, also written by Kay, employed various types of evaluation items including short answer questions. The students, accustomed to multiple-choice items only, complained, eventually resulting in Kay's yielding to pressure to teach and test exactly as her cooperating teacher did. This resulted in Kay's developing negative beliefs about the students such as "they don't know how to think." However, she maintained her earlier beliefs in non-traditional teaching and was convinced that she would be able to teach successfully in this way if she had her own class from the beginning of the year.

In summary, Kay and Sean both believed that students should be actively involved in their own learning. Sean was able to express his beliefs in concrete terms and to anticipate student outcomes. He was able to use a variety of strategies to plan lessons which reflected his beliefs. Kay focused on the content to be taught in planning lessons but was unable to take the students into account in her planning. When dissatisfied with her teaching, she was not able to clearly identify the source of her dissatisfaction. Therefore, while Sean's self-evaluations influenced his later planning, Kay's self-evaluations may not

have been specific enough to inform her later planning. Since Kay faced severe constraints in her planning during student teaching, she may simply not have had the opportunity to learn from earlier mistakes which Sean, with virtually unlimited freedom, had.

Discussion

In these studies the preserivce teachers shared some common beliefs, possibly reflecting the influence of the secondary science education classes. They believed students should be actively involved in learning science and that science teaching should employ concrete activities that allow students to be actively involved in constructing scientific knowledge.

As was found in Zahorik's (1975) study, many of the informants discussed in this study were concerned with the content to be taught. In some cases, they engaged in intense study of the content to expand their own content knowledge, to familiarize themselves difficulties students might have in learning the content, and to think about how to best present the content to the students.

All of the prospective teachers in our study spent much of their planning time finding, or developing, activities to be used in their lessons. Another common concern among the prospective teachers was time management. Sean successfully managed time in many lessons by planning alternate activities which he could use depending, in part, on how well he was managing time. Most of the others were concerned about having enough materials to last

the full time period. Consistent with Tailor's (1970) study, the informants in these studies, with the exception of Sean, devoted very little of their planning to evaluation.

Resources employed by these prospective teachers in their planning included the cooperating teacher, science education students or faculty, their own college textbooks, and outside resources, such as library books or outside businesses or agencies. Most of the prospective teachers relied primarily on their own textbooks, their cooperating teachers, and their science education instructors indicating that college courses and cooperating teachers are likely to have a strong impact on the teaching of prospective teachers. These findings are in conflict with (Sanford, 1987) paper claiming that cooperating teachers are the only resource in student teachers' planning.

Although the prospective teachers expressed similar beliefs about planning and used similar resources, the actual procedures employed in planning lessons was idiosyncratic. For instance, Tina wrote down key points she wished to teach and then searched for activities which fit these key points. Sally and Kay had similar strategies. Kay differed in that she combined searching for activities with developing parts of activities herself. Sally wrote detailed procedures which she would follow in the classroom while Kay's planning for her own classroom behavior was summarized in short paragraphs. Chuck developed his own activities and questions while Sean obtained ideas for activities from outside resources and supplemented these with materials he

developed himself. This diversity in planning strategies supports a similar finding reported by Zahorik (1975).

Other subtle differences were apparent among the prospective teachers in spite of the similarities in their expressed beliefs. For instance, Tina focused on using work-sheets to enhance students' learning. Therefore, much of her effort in planning was devoted to designing worksheets. Chuck used activities to promote students' interest in their learning and to encourage students to assume responsibility for their own learning. Both Chuck and Sean emphasized the importance of relating the content to the students and activities, in part, served this function. Sally's belief in the importance of applying content knowledge was reflected in her lesson plans which emphasized the application of content knowledge to real life situations.

Our findings indicate that prospective teachers' beliefs do influence their planning but not in easily predictable ways. Even prospective teachers with very similar beliefs about what constitutes good science teaching have different emphases within those commonly held beliefs. The beliefs may hold subtle differences in meaning from person to person even when expressed in almost identical language. Prospective teachers ability to translate these beliefs into concrete terms and their knowledge of their students also influence the way their beliefs will be expressed in practice. The extent to which prospective teachers are free to plan as they wish obviously influences the extent to which their beliefs can influence their planning during student

teaching.

Conclusions and Implications

The findings from these studies support the contention that beliefs are a dominant factor in influencing teachers' planning. The prospective teachers in our studies attached much importance to their planning, focusing especially on content, activities, organization, and timing.

Contrary to the opinions of many researchers (Lortie, 1977) the similarity of the beliefs expressed by the prospective teachers in these studies indicate that teacher educators may influence prospective teachers' developing beliefs, or reinforce existing beliefs. However, the differences in the meanings and implementation of these beliefs may reflect earlier school experiences on the part of the prospective teachers. Since the ability to clearly articulate their beliefs in concrete terms impacts prospective teachers' ability to plan lessons which reflect their beliefs, we recommend that teacher educators promote self-reflection among preservice teachers in order to help preservice teachers develop an awareness of their own beliefs. We also recommend that teacher educators approach planning from the bottom up, that is, developing a concrete picture of what will be covered in the lesson, rather than using the traditional approach of planning from objectives. Finally, we recommend that teacher educators put more emphasis on how to manage timing and organization in planning lessons.

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