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AUTHOR	Shaw, Edward L., Jr.; Cronin-Jones, Linda
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ABSTRACT

For many years, researchers and teachers have highlighted the many striking differences between content area knowledge of teachers and teaching practices of elementary and secondary teachers. In addition, numerous studies have compared the instructional repertories and effectiveness of teachers at the elementary and secondary levels. Researchers and practitioners have also begun to acknowledge the important influence that teachers' beliefs have on different aspects of the teaching/learning process. In this study, the beliefs of pre-service elementary and secondary science teachers before and after a science methods course, and the changes in those beliefs during this time were investigated. The belief structures of the elementary and secondary teachers before and after the methods course were compared and analyzed. Results indicated that: (1) the belief structures of elementary teachers were more simplistic than those of secondary teachers; (2) there was no typical pre-service teacher belief structure; (3) pre-service teachers already possessed some knowledge about teaching and had an organized belief structure regarding teaching when they entered the methods instruction; and (4) the primary area of concern for most teachers centered around students and the second most dominant area of concern centered around the task of teaching. (CW)

Influence of Methods Instruction on Pre-Service Elementary and Secondary Science Teachers' Beliefs

Edward L. Shaw, Jr.
Early Childhood and Elementary Education
College of Education
The University of South Alabama
Mobile, Alabama 36688

Linda Cronin-Jones
Department of Instruction and Curriculum
258 Norman Hall
The University of Florida
Gainesville, Florida 32611

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The Influence of Methods Instruction on the Beliefs of Pre-Service Elementary and Secondary Science Teachers: Preliminary Comparative Analyses

For many years, both researchers and practitioners have highlighted the many striking differences between the content area knowledge and teaching practices of elementary and secondary level teachers. In addition, numerous studies have compared the instructional repertories and effectiveness of teachers at the elementary and secondary levels. Although hundreds of studies have documented the performance and behaviors of elementary and secondary level teachers, very few of these studies have included an examination of the underlying beliefs influencing these observable behaviors. As Munby (1983) has indicated, researchers must go beyond the realms of behavior and knowledge and conduct studies of teacher beliefs in order to develop a truly accurate description of the teaching process.

Recently, researchers and practitioners have begun to acknowledge the important, yet poorly understood influence that teacher beliefs have on virtually every aspect of the teaching/learning process (Cronin, 1986). Clark and Peterson (1986) have documented the strong link between teacher beliefs and teacher actions, but the majority of research conducted in this area has focused almost exclusively on veteran teachers (i.e. teachers with three or more years of experience). While the data generated from these studies indicate that the beliefs of veteran teachers are typically well-grounded and extremely resistant to change (Munby, 1982), it appears that the beliefs of pre-service and novice teachers might be quite amenable to change as a result of instruction and/or experience.

Researchers such as Mayer and Goldsberry (1987) have indicated that the ideal time to explore the beliefs of teachers is during the early stages of a teacher's development. They hypothesize that during these early stages teacher beliefs tend to be in a state of flux. Other researchers, including Peterson, Fennema, Carpenter, and Loef (1987) have also highlighted the importance of studying teacher beliefs within the content of particular subjects, such as science and mathematics. They have identified the limitations of studies focusing on teacher beliefs across a wide range of curriculum areas. Other researchers, including McNair (1979), have indicated that grade level could contribute significantly to the differences in teacher beliefs and performance and warrants more study. Finally, Hollon and Anderson (1987) have stated that more detailed comparisons of the beliefs of elementary versus secondary teachers are needed.

OBJECTIVES

This study attempted to address the concerns of researchers in the area of teacher beliefs by: (1) focusing on the beliefs of teachers during the early stages of their development, (2) concentrating on the beliefs of teachers within one subject area (science), and (3) exploring the belief structures of teachers from different grade levels. This study was designed to utilize qualitative and quantitative research techniques to: (1) determine the beliefs of pre-service elementary and secondary level science teachers before and after participation in a science methods course, (2) describe the changes in pre-service teacher beliefs resulting form participation in a science methods course, and (3) compare and contrast the belief structures of pre-service elementary and secondary level teachers both before and after completion of a science methods course.

DESIGN AND PROCEDURES

The data collection and analysis techniques used in this preliminary study were designed to elicit more reliable and valid data by minimizing the potential distorting influence of researcher-imposed perspectives. In order to accomplish this goal, the methodology employed in this study consisted of the repertory grid technique fortified with factor analysis.

DATA COLLECTION

Pre-service elementary and secondary science teacher beliefs were elicited in interviews conducted both before and after the completion of a science methods course during the 1987-88 school year. Repertory grids were generated by asking preservice teachers two sets of questions. First, each student was presented with the following scenario and questions: "Imagine you are teaching the grade level you like best and the subject you like best in a school and classroom in which you feel comfortable. If I were to observe you teaching for one full class period, what would I see going on from start to finish? What would you do and what would the students do?" Student were reminded to focus on events, behaviors, and activities rather than descriptions of what the room would look like.

The specific descriptions of behaviors generated from this scenario and questions were listed on the horizontal "elements" axis of the grid. After each student was finished responding, the list of behaviors he/she generated was read aloud and the student was asked to make changes, additions, or deletions.

Next, each student was asked to look over his/her list of behaviors and was asked, "Why would you do the things you listed and why would the students do the things you listed? You don't have to identify a specific reason for each individual behavior, but rather think about your reasons in general terms." The set of reasons generated from this question formed the vertical "constructs" axis of the grid. After each student was finished responding, the list of reasons was read aloud and the student was asked to make any changes, additions, or deletions. Each respondent was allowed to list as many behaviors and reasons as they wished and no time limit for responding was imposed. Although some of the descriptions of behaviors and reasons were paraphrased, they still contained only the actual words used by each student.

After the axes of the grid were completed, each student filled in all of the cells of his/her grid with numbers ranging from one to three. These numbers (1=definitely not related, 2=neutral - might or might not be related, 3=definitely related) indicated each student's perceived relationship between each behavior (element) and each reason (construct) on his or her own grid. Figures 1 and 2 contain sample completed repertory grids for an elementary and secondary science methods student, respectively.

Each completed grid was factor analyzed using a computer generated principal components analysis with varimax rotation. The expectation was that the variables (constructs) with some commonality would be placed in the same factor. Summaries of factors and their component student-generated constructs from both the principal components and varimax rotation analyses were then developed. Constructs which had negative loadings for all factors or which showed no variance were not included in the summaries. A sample factor analysis summary sheet for an elementary student is included is included in Figure 3 while Figure 4 contains a secondary student's factor analysis summary sheet.

DATA SOURCES

The sample for this study consisted of two groups. Group 1 was composed of 12 undergraduate elementary education majors enrolled in a teacher preparation program in Alabama. All of the students were females whose ages ranged from 21 to 39 years. At the time of the study, all of the elementary education students were completing their senior year and were enrolled in a science methods course.

Group 2 was composed of 12 secondary science education majors enrolled in a graduate level teacher preparation program in Florida. All 12 of these students had bachelor's degrees in their science subject areas (e.g. Biology , Chemistry, and Physics). Eight of the students were female and four were male. They ranged in age from 22 to 45 years. At the time of the study, all of the students were beginning their first full semester of graduate work.

DATA ANALYSIS

The repertory grids and factor structures generated for each student were analyzed on two levels. First, they were reviewed to determine major categories of focus. Next, component sub-categories were identified until all factors, constructs, and narrative statements could be assigned to a particular sub-category. In the second level of analysis, comparisons were made between the organization and content of the grids and factor structures developed before and after completion of the science methods course. These changes were examined on both individual and collective levels for both groups.

RESULTS

For the pre-service elementary students, the number of factors generated from a given grid ranged from one to three for grids generated both before and after completion of the science methods course. The mean number of factors generated for the group as a whole was two for both pre- and post-methods grids. The total number of constructs generated ranged from four to 17 for pre-methods instruction grids (mean=10) and from five to 15 for post-methods instruction grids (mean=8.2). The number of constructs contained in individual factors ranged from three to 11 (mean=6.6) for pre-methods grids and from three to eight (mean=5.1) for post-methods grids.

For the pre-service secondary students, the number of factors generated from a given grid ranged from two to five for pre-methods grids and from two to six for post-methods grids. The mean number of factors generated for the group as a whole was three for both pre- and post-methods instruction grids. The total number of constructs generated ranged from four to 20 for pre-methods instruction grids (mean=10) and from five to 19 for post-methods grids (mean=11). The number of constructs contained in individual factors ranged from one to seven for both pre- and post-methods grids and the mean number of constructs per factor was 3.3 for pre-methods grids and 3.6 for post-methods grids.

CHARACTERISTICS OF FACTOR STRUCTURES

When factors and their component constructs were examined for the elementary students, four major categories or areas of focus were identified. These same four categories were present to at least some degree in both pre- and post-methods data sets. Two of these categories focused on specific concerns while two other categories focused on more broad or general concerns. Specific categories included concerns related to the outcomes, needs, or characteristics of STUDENTS and concerns related to the TASK of teaching. Broad categories included concerns regarding the complex concepts of TEACHING and LEARNING. A summary of the types of specific and broad concerns identified in pre- and post-methods structures is included in Table 1.

As indicated in Table I, all 12 elementary education students focused on task-oriented concerns both before and after completion of the methods course. In addition, while 11 of the 12 students included a focus on student needs and characteristics before completion of the methods course, all 12 students included student-oriented concerns in their post-methods factor structures. Broad concerns related to the complex concepts TEACHING and LEARNING were less common in the pre-methods factor structures, but these broad concerns were evident in all 12 elementary students' post-methods factor structures.

Although the major categories or types of concerns evident in the elementary students' factor structures were all rather similar, variability did occur in the specific constructs selected for different students' factor structures. Upon examining the specific variables included in different factors, 10 different sub-categories of concern were identified. Only one student selected all 10 sub-categories on both the pre- and post-methods data sets. All 12 elementary students selected at least five of these sub-categories. A summary of the types of sub-categories included in pre- and post-methods instruction grids and factor structures is included in Table 2.

When factors and their component constructs were examined for the secondary education students, five major categories or areas of focus were identified. These same five categories were present to at some degree in both pre- and post-methods data sets. Two of these categories focused on specific concerns while three other categories focused on more broad or general concerns. Specific categories included concerns related to the outcomes, needs, or characteristics of STUDENTS and concerns related to the TASK of teaching. Broad categories included concerns regarding the complex concepts of TEACHING and LEARNING and the appreciation or value of science as a SUBJECT. A summary of the types of specific and broad concerns identified in the grids and factor structures generated before and after methods instruction for the secondary students is included in Table 3.

Regarding the specific categories, STUDENT concerns were the most stable and prevalent components of secondary student belief systems both before and after completion of the methods course. All 12 secondary students' grids and factor structures reflected STUDENT- oriented concerns in both pre- and post-methods analyses. TASK- oriented concerns were identified in the pre-methods grids and factor structures of 10 students and were evident in the post-methods grids and factor structures of eight students. Two students did not identify any TASK oriented concerns in either pre- or post-methods data sets.

Regarding the broader categories, four of the 12 secondary students involved in the study included at least one broader area of focus in both pre- and post-methods grids and factor structures. Two students included two broad categories prior to the completion of methods course and another two students included two broad categories after completion of the methods course. Prior to completion of the methods course, five students identified a concern for the broad category of TEACHING and three students identified a concern for the broad category of LEARNING. After completion of the methods course, three students included a concern for the broad TEACHING category and two students identified a broad LEARNING concern. Broad SUBJECT concerns were only identified by one student prior to completion of the methods course but emerged in post-methods analyses of four students.

Although the major categories or types of concerns evident in the students' grids and factor structures were rather similar, the exact nature of the concerns within both broad and specific categories differed greatly from student to student. Upon examining the specific variables included in different factors, 18 different sub-categories of concern were identified. A summary of the types of sub-categories included in the secondary students pre- and post-methods instruction grids and factor structures is included in Table 4.

It is interesting to note that analysis of the repertory grids of three pre-service elementary students yielded one factor solutions both before and after completion of the science methods course. In addition, the repertory grids generated after completion of the methods course yielded one factor solutions for six other students. No one factor solutions were generated from analyses of the secondary students' grids either before or after completion of the science methods course.

SPECIFIC CONCERNS

STUDENT CONCERNS

For the elementary education students, sub-categories in the STUDENT category centered around student outcomes and student characteristics or needs. Beliefs about the importance of two different student outcomes were identified. Cognitive outcomes included knowledge of explanations and conceptual understanding of material. Seven students included concerns for cognitive student outcomes in their factor structures. Behavioral outcomes included desired student behaviors like making collections of objects for certain activities or discovering answers by themselves. Ten students included an emphasis on behavioral outcomes in their factor structures. Three students included an emphasis on both cognitive and behavioral outcomes. Overall, the pre-service elementary students focused primarily on the behavioral aspect of student outcomes.

Elementary education students focused on student outcomes more often after methods instruction (18 total outcome concerns) than before methods instruction (14 total outcome concerns). Every student indicated at least one student outcome concern in either the pre- or post-methods analyses.

For the secondary education students, sub-categories in the STUDENT category also centered around student outcomes and student characteristics or needs but the sub-categories of emphasis were more diverse than those identified by elementary students. Secondary students emphasized the importance of five different student outcomes. Cognitive outcomes included factual learning and conceptual understanding of material while affective outcomes included student feelings of comfort or enjoyment of class activities. Six students included concerns for cognitive outcomes and 11 students included concerns for affective outcomes. Behavioral outcomes included desired student behaviors like listening or participating while social outcomes included the ability of students to get along with each other or function in group settings. Four students included an emphasis on behavioral outcomes and seven students included an emphasis on social outcomes. Skill development outcomes focused on both manipulative skills and thinking skills. Eight students included an emphasis on skill development.

Overall, secondary education students also focused on student outcomes more often in post-methods analyses (32 total outcome concerns) than in pre-methods analyses (23 total outcome concerns). Only one student did not focus on student outcomes either before or after methods instruction.

Beliefs about student characteristics and needs included both positive and negative views of students. Examples of identified student needs included the need for direction or orientation, the need for personal contact, the need for concrete experience, the need for multiple stimuli, and the need for practice. Examples of beliefs about student characteristics included statements such as "Students are not automatically ready to work," "Science class is not a priority for students," "Students do not prepare much before class," "Students are not well-trained listeners," and "Students sometimes try to bother teachers." Only seven of the elementary students included a component focusing on student needs or characteristics while 11 of the secondary students included an emphasis on student needs or characteristics.

TASK CONCERNS

For the elementary education students, TASK concerns were the most stable and prevalent components of factor structures both before and after the methods course. Three sub-categories of TASK concerns were identified. These sub-categories focused on planning practices, instructional techniques, and strategies for creating a positive learning environment. Nine of the elementary students included a focus on instructional techniques in either the pre- or post-methods analyses. Learning environment concerns were present in seven students' pre-methods factor structures and in 10 students' post-methods factor structures. An emphasis on the importance of teacher planning emerged in all 12 students' factor structures after the completion of the methods course. All 12 student's pre- and post-methods factor structures included at least two TASK concerns while all three TASK concerns emerged in the pre- and post-methods factor structures of seven students.

For the secondary education students, six sub-categories of TASK concerns were identified. These sub-categories focused on planning practices, instructional techniques, behavior management techniques, strategies for creating a positive learning environment, provisions for assessment of student outcomes, and administrative responsibilities associated with teaching. The most prevalent TASK concerns centered around the area of instruction. Ten students included a focus on instructional techniques in both pre- and post-methods analyses. Learning environment concerns represented the second most common area of focus and were identified by seven students. Three students included time management and /or behavior management concerns before methods instruction and four students included such concerns after methods instruction. A need for assessment of student outcomes was only expressed by three students and only one student included an administrative procedure component in her factor structures. Two students did not indicate any TASK oriented concerns following methods instruction and two other students did not express TASK oriented concerns either before or after completion of the methods course. In general, TASK oriented concerns tended to remain stable before and after methods instruction, with a total of 21 TASK concerns identified before the methods course and a total of 22 TASK concerns identified after the methods course.

BROAD CONCERNS

For the elementary education students, the two major categories of broad concerns focused on TEACHING and LEARNING. Teaching concerns were evident in all of the elementary students' structures. There was only one sub-category of this broad concern and that was the role of a teacher. Nine students identified at least one concern in this sub-category in both the pre- and post-methods analyses.

LEARNING concerns were present in either the pre- or post-methods factor structures of all of 12 elementary education students. Two different types of LEARNING concerns were identified. One sub-category focused on the intrinsic value of learning itself, regardless of subject area. Three students expressed a belief in the intrinsic value of learning. Another sub-category focused on the future value of learning. All 12 students included an emphasis on the future value of learning in their post-methods factor structures. A final sub-category reflected an emphasis on the need for a broad understanding of science as a subject. Only four students included an emphasis on this need for broad learning. Only one student identified concerns in all three sub-categories on both the pre- and post-methods analyses.

For the secondary education students, three major categories of broad concerns were identified. In addition to the TEACHING and LEARNING concerns identified by the elementary students, a third unique category reflecting a strong belief in the value of science as a SUBJECT emerged. TEACHING concerns were the most common broad category of concern identified by secondary students. This category included concerns related to the characteristics or role of a teacher as well as a belief in the value or enjoyment of teaching. Five students included an emphasis on the characteristics or role of a teacher and one student stressed the value or enjoyment of teaching in general. Beliefs about the characteristics or role of a teacher were reflected in statements such as "Teachers shouldn't have to do everything" and "Teacher enthusiasm is important".

Only two types of LEARNING concerns were identified by secondary students. These sub-categories included a focus on the future, long-term value of learning and an emphasis on the need for a broad understanding of the nature of science and science subject matter. LEARNING concerns were only identified by three secondary students.

Finally, four students expressed a concern based on the appreciation or love of science as a SUBJECT. This SUBJECT concern emerged most often in post-methods analyses and was reflected in statements such as "Science is a dynamic, important subject" and "Biology is the greatest subject on earth".

CHANGES IN CONCERNS

In general, for the elementary students the types of specific concerns (STUDENT and TASK) included in factor structures were stable in both pre- and post-analyses. For example, students with STUDENT and TASK concerns before the methods course instruction tended to retain such concerns after the completion of the instruction. However, although the overall categories of focus were consistent from pre- to post-analyses, the specific sub-categories emphasized often differed in pre- and post-analyses. The 12 students' sub-categories were similar but not all of the subcategories were identified each time by each student.

Broad categories of emphasis (TEACHING and LEARNING) were very similar in pre- and post-analyses for individual students. Four of the elementary students retained the identical TEACHING and LEARNING concerns from pre- to post-analysis.

For the secondary students, the types of specific concerns (STUDENT and TASK) included in factor structures also remained consistent before and after methods instruction. For example, students with TASK concerns before the completing the methods course tended to retain such concerns after the completing the methods course. However, like the elementary students, the specific sub-categories emphasized in each category often differed in pre- and post-analyses. Only two students exhibited the exact same set of STUDENT concerns before and after completion of the methods course and no students focused on the same sub-categories of TASK concerns before and after methods instruction. Broad categories of emphasis identified by secondary students (TEACHING, LEARNING, and SUBJECT) seemed to be vary greatly from pre- to post-methods analyses.

DISCUSSION

The preliminary analyses conducted thus far indicate that certain basic differences do exist between the belief structures and concerns of pre-service elementary and secondary science teachers. For the elementary methods students, the following trends were observed: (1) the mean number of factors generated before and after methods instruction remained the same; (2) the mean number of constructs generated decreased from pre- to post-methods instruction; (3) the mean number of constructs per factor decreased from pre- to post-methods instruction. These results indicate that although the overall organization of elementary students' beliefs (as reflected in the number of factors generated) about teachers did not change much as a result of participation in the methods course, the specific foci of their beliefs about teaching did change. Generally, it appears that the elementary students seemed to narrow their foci as a result of participation in the methods course.

Regarding the secondary methods students, trends from pre- to post-methods instruction included the following: (1) the mean number of factors generated before and after methods instruction remained the same; (2) the mean number of constructs generated increased from pre- to post-methods instruction; (3) the mean number of constructs per factor also slightly increased from pre- to post-methods instruction. Like the elementary students, it appears that although the overall organization of secondary students' beliefs about teaching did not change much as a result of participation in the methods course, the specific foci of their beliefs about teaching did change. In contrast to the elementary students, however, secondary students seemed to broaden and vary their foci as a result of participation in the methods course.

In addition, although both groups tended to retain the same number of factors from pre- to post-methods instruction, the belief structures of the elementary students seemed to be more simplistic, as evidenced by the high number of one factor solutions and a mean of two factor solutions for the group. In contrast, no secondary students elicited one factor solutions and the mean number of factors generated per student was three. Thus, it appears that the secondary students possess more complex belief structures regarding teaching and learning and include an emphasis on some areas which are virtually absent from the belief structures of elementary students. Examples of areas of focus unique to the secondary students participating in this study include STUDENT skill development concerns, TASK concerns related to assessment, and a general SUBJECT concern.

The results of this study affirm the predominant view that pre-service teachers already possess some knowledge about teaching and have an organized belief structure regarding teaching when they enter methods instruction. In addition, these results support the findings of McNair (1979), Michelsen (1987), and others who report that pre-service teachers possess unique belief structures regarding teaching both before and after methods instruction, but also report that the basic categories of emphasis within belief structures are rather similar among teachers.

Finally, the results of this study are consistent with those reported by researchers including McNair (1979) and Neale, Smith, and Wier (1987) who report that the primary area of concern for most teachers centers around STUDENTS and the second most dominant area of concern centers around the TASK of teaching.

IMPLICATIONS

The results of this study raise some important issues for science teacher educators. First, these studies indicate that the belief structures of elementary teachers are more simplistic than those of secondary teachers. Thus, it appears that elementary methods courses need to focus more directly on expanding and organizing the belief structures of pre-service elementary education students. In addition, the results of this study indicate that there is no such thing as a "typical" pre-service teacher belief structure. As such, there can be no such thing as a "generic" or "typical" methods course. These results support the views of Michelson (1987) and Hewson and Hewson (1988) who contend that teacher educators should first find what the existing belief structures of their students are before methods instruction begins and tailor instruction accordingly.

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Name Sue
Date 4/88

3= definitely associated
2= neutral
1= definitely NOT associated

	Students use manipulatives	Teacher uses concrete materials	Teacher does something new everyday	Students work at discovery table	Teacher uses lots of examples	No textbook is used	Students see pictures	Students work on interactive bulletin boards	Students are not forced to enjoy class	Teacher spends 40 minutes on science	Time is allotted for science activities	Students participate in spontaneous activities	Teacher tells students something fascinating
V1- Science class should be structured for creativity	3	3	3	3	3	2	2	3	3	2	3	3	3
V2- Science class should not turn kids off	3	3	3	3	3	3	3	2	3	2	2	3	3
V3- Students need to do something that is fun	3	3	3	3	2	3	3	3	3	2	2	3	3
V4- Comprehension is important	3	3	2	3	3	1	3	3	2	2	3	2	2
V5- Students should have hands-on experience	3	3	3	3	3	3	3	3	1	2	3	3	3
V6- Time factor for completing activities should be considered	2	2	2	2	2	3	2	3	2	3	3	2	2
V7- Motivational activities should be included	3	3	3	3	3	2	3	3	3	2	2	3	3

Figure 1: Sample repertory grid for elementary education student

Name Elizabeth
Date 1/9/88

3= definitely associated
2= neutral
1= definitely NOT associated

	students have task right away	teacher greets students at door	teacher has students' attention	teacher introduces/reviews material	teacher presents material	teacher uses film/ activity	class cleans up	teacher summarizes	students ask lots of questions	students generate ideas	teacher monitors behavior	teacher circulates	teacher gets most students involved	teacher incorporates current or relevant events	teacher encourages students to see her/him after school	teacher stops if students aren't catching on	teacher tosses plans if not working	teacher tries to notice students with problems	students leave room thinking	teacher encourages students to do homework	teacher allows time at end of period	teacher is relaxed with students	teacher uses humor	classroom is neat; teacher stresses neatness	teacher uses positive reinforcement	teacher elaborates on students' ideas	teacher gives students something to look forward to
V1 - need to consider long-term retention	2	1	2	3	3	3	1	3	2	3	2	2	2	3	2	3	3	2	3	3	1	2	2	[illegible]	2	3	3
V2 - students should enjoy going to school	1	3	1	2	1	3	1	2	3	3	2	2	3	3	2	3	3	3	3	3	3	3	3	3	2	2	3
V3 - students should feel comfortable in class	3	3	2	2	2	2	2	2	2	2	3	3	2	2	3	3	3	3	2	2	3	3	3	3	2	2	2
V4 - important to teach students how to learn successfully	3	2	3	3	3	3	2	3	3	3	3	3	3	3	3	2	2	2	3	3	3	2	2	3	2	3	3
V5 - need to stimulate desire to learn	3	3	3	3	2	3	1	3	3	3	1	1	3	3	3	2	2	2	2	3	2	2	2	2	2	3	3
V6 - students should be encouraged	3	3	2	3	2	3	1	3	3	3	1	1	3	3	3	2	2	2	2	3	2	3	3	2	3	3	3
V7 - students should realize science is important	2	2	3	3	3	2	1	3	3	3	1	1	3	3	3	3	3	1	3	3	1	1	1	1	2	2	2
V8 - need to have a nice atmosphere	2	3	3	3	2	2	3	2	3	3	3	3	3	2	3	3	3	3	1	1	3	3	3	3	2	3	3
V9 - students should feel they are working toward a goal	3	1	3	3	3	2	1	3	3	3	1	1	3	2	3	3	3	2	3	3	2	2	2	3	3	3	3
V10 - students should feel actively involved	3	1	3	3	3	3	3	3	3	3	1	1	3	2	3	3	3	2	3	3	2	2	2	3	3	3	3
V11 - students should feel responsible for own learning	3	1	3	3	3	3	3	3	3	3	1	1	3	2	3	2	2	3	3	3	2	2	2	3	3	3	3
V12 - students should know teacher has high expectations	3	2	3	3	3	3	3	3	2	2	1	1	3	2	3	2	2	2	3	3	2	2	2	3	3	2	3
V13 - students should feel they can achieve	2	2	2	2	2	2	2	3	3	3	2	2	3	2	3	3	3	3	3	3	2	3	2	2	3	3	3
V14 - variety is important	2	1	2	3	3	3	1	3	3	3	1	1	3	3	1	3	3	1	2	3	2	2	1	1	1	2	3

Figure 2: Sample repertory grid for secondary education student

FACTOR STRUCTURES - SUE
4/88

NORMAL

Factor 1

V2 - Science class should not turn kids off
V6 - Time factor for completing activities should be considered
V7 - Motivational activities should be included

Factor 2

V4 - Comprehension is important

V1, V3, V5 - OUT: not enough variance occurred

VARIMAX ROTATION

Factor 1

V2 - Science class should not turn kids off
V3 - Students need to do something that is fun
V6 - Time factor for completing activities should be considered
V7 - Motivational activities should be included

Factor 2

V1 - Science class should be structured for creativity
V4 - Comprehension is important

V5 - OUT: Not enough variance occurred

Figure 3: Sample factor analysis summary sheet for elementary education student.

FACTOR STRUCTURES - BETH

1/88

NORMAL

Factor 1

V1 - Need to consider long term retention
V4 - It's important to teach students how to learn successfully
V5 - Need to stimulate the desire to learn
V6 - Students should be encouraged
V7 - Students should realize science is important
V9 - Students should feel they are working toward a goal
V10 - Students should feel actively involved
V11 - Students should feel responsible for their own learning
V12 - Students should know the teacher has high expectations
V14 - Variety is important

Factor 2

V2 - Students should enjoy going to school
V3 - Students should feel comfortable in class
V13 - Students should feel they can achieve

Factor 3

V3 - Need to have a nice atmosphere

VARIMAX ROTATION

Factor 1

V9 - Students should feel they are working toward a goal
V10 - Students should feel actively involved
V11 - Students should feel responsibility for their own learning
V12 - Students should know the teacher has high expectations

Factor 2

V1 - Need to consider long term retention
V4 - It's important to teach students how to learn successfully
V7 - Students should realize science is important
V14 - Variety is important

Factor 3

V5 - Need to stimulate the desire to learn
V6 - Students should be encouraged

Factor 4

V2 - Students should enjoy going to school
V3 - Students should feel comfortable in class
V8 - Need to have a nice atmosphere
V13 - Students should feel they can achieve

Figure 4: Sample factor analysis summary sheet for secondary education student.

Table 1

Specific and Broad Concerns of Preservice Elementary Science Education Students

Name	Before Methods Course				After Methods Course			
	Specific		Broad		Specific		Broad	
	Student	Task	Teach	Learn	Student	Task	Teach	Learn
Sandy	X	X	X	X	X	X	X	X
Kitsy	X	X	X	X	X	X	X	X
Mary	X	X	X	X	X	X	X	X
Mary Ann	X	X	X	X	X	X	X	X
Sue	X	X	X	X	X	X	X	X
Linda	X	X	X	X	X	X	X	X
Carolyn	X	X		X	X	X	X	X
Bessie	X	X		X	X	X	X	X
Mary Jo	X	X	X	X	X	X	X	X
Diana	X	X	X		X	X	X	X
Ann		X			X	X	X	X
Angie	X	X	X	X	X	X	X	X

Table 2

Sub-Categories Identified in Factor Structures of Elementary Science Education Students

	Sandy		Kitsy		Mary		Mary Ann		Sue		Linda		Carolyn		Bessie		Mary Jo		Diana		Ann		Angie	
	Pre	Post	Pre	Post	Pre	Post	Pre	Post	Pre	Post	Pre	Post	Pre	Post	Pre	Post	Pre	Post	Pre	Post	Pre	Post	Pre	Post
Specific																								
Students																								
Outcomes																								
cognitive		X	X	X	X	X	X	X				X							X	X		X	X	X
behavioral	X	X			X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X				X
Characteristics/Needs			X	X	X	X	X	X				X	X	X	X	X	X	X					X	X
Task																								
Planning	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Instruction	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X		X	X	X
Learn. Environ.		X	X	X			X	X	X	X		X	X	X	X	X	X	X	X	X				X
Broad																								
Teaching																								
Role of a teacher	X	X	X	X	X	X	X	X	X	X	X	X		X		X	X	X	X	X		X	X	X
Learning																								
Intrinsic value							X	X					X	X		X								
Long-term value	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X		X		X	X	X
Broad understanding of subject	X	X					X	X			X	X					X	X						

Table 3

Specific and Broad Concerns of Preservice Secondary Education Students

Name	Before Methods Course					After Methods Course				
	Specific		Broad			Specific		Broad		
	Stud	Task	Tchg	Lrng	Subj	Stud	Task	Tchg	Lrng	Subj
Sally	X	X		X		X			X	X
Beth	X	X	X			X	X	X		X
Charlotte	X	X	X			X	X	X		
Cheri	X	X	X			X	X			
Lynda	X	X				X	X		X	X
Andy	X	X				X	X			
Robbie	X		X		X	X				X
Amanda	X	X				X				
Mike	X	X				X	X	X		
Vonda	X	X				X	X			
Chris	X			X		X				
Pete	X	X	X	X		X	X			

Table 4

Sub-Categories Identified in Factor Structures of Secondary Science Education Students

	Sally		Beth		Charlotte		Chen		Lynda		Andy		Robbie		Amanda		Mike		Vonda		Chris		Pete	
	Pre	Post	Pre	Post	Pre	Post	Pre	Post	Pre	Post	Pre	Post	Pre	Post	Pre	Post	Pre	Post	Pre	Post	Pre	Post	Pre	Post
SPECIFIC																								
STUDENTS																								
Outcomes																								
cognitive	X	X				X				X			X	X								X		X
affective	X	X	X	X		X	X		X	X		X	X	X	X	X				X	X	X	X	X
behavioral			X	X				X		X													X	
social		X							X	X	X	X	X	X		X						X	X	
skill development	X	X	X	X		X			X				X	X	X	X				X			X	X
Characteristics/Needs			X	X	X	X	X			X	X	X	X	X	X		X	X	X	X		X	X	X
TASK																								
Planning							X	X		X					X			X		X				
Instruction	X		X	X	X	X		X		X	X						X	X		X			X	X
Management			X					X		X	X	X						X					X	
Learn. Env.	X			X	X	X	X		X	X	X								X	X				
Assessment			X		X	X				X							X			X				
Administrative					X																			
BROAD																								
TEACHING																								
Characteristics/Role of a teacher			X	X	X		X						X					X						X
Value/Enjoyment of teaching																								
LEARNING																								
Intrinsic value		X																			X			
Long-term value																								
Broad understanding of subject	X	X								X													X	
SUBJECT																								
Love/Appreciation of science		X		X						X			X	X										

29