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Path analytical models of variables that influence science and chemistry teaching self-efficacy and outcome expectancy in middle school science teachers

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PATH ANALYTICAL MODELS OF VARIABLES THAT INFLUENCE SCIENCE AND CHEMISTRY TEACHING SELF-EFFICACY AND OUTCOME EXPECTANCY IN MIDDLE SCHOOL SCIENCE TEACHERS

by

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CHAPTER ONE

INTRODUCTION TO THE STUDY

Factors that influence science and chemistry teaching self-efficacy and outcome expectancy in middle school science teachers were examined in this study. In chapter one a background is presented that includes the importance of scientific literacy for today's society, especially in chemistry. The unique nature and contribution of middle school science education to this literacy is discussed. In addition, an explanation of teacher efficacy belief systems and the role they play in predicting teacher behavior follows. A theoretical framework grounded on the theories of Albert Bandura is then developed. The significance of the study is stated and pertinent definitions are provided. Research hypotheses based on statistical path analyses are presented. The chapter closes with assumptions, limitations and delimitations of the study.

BACKGROUND FOR THE STUDY

Need for Literacy in Science and Chemistry

Many dilemmas people face as individuals and as a society are related to science and specifically rooted in chemistry. Clothes, food, cleaning supplies, pharmaceuticals, toiletries, pesticides and a variety of other products come with extensive labeling about their chemical make-up. The use and placement of nuclear power plants, proposed destruction of the ozone layer by refrigerants containing chlorofluorocarbons, disposal of hazardous wastes and mountains of nearly indestructible plastic garbage, concern about exposure to hazardous materials in the school and workplace, and the clean up of oil spills are only a few examples of chemistry related issues people must face as a society. In order to understand and make decisions about the complexities of these situations, it is crucial that individuals have an understanding of science, especially chemistry.

In spite of a crucial need for individuals to understand science and chemistry, high school enrollments in science have been declining, especially in chemistry. Only 37 percent of public and private high school students presently enroll in chemistry (Odell & Fifer, 1985). Declines in chemistry enrollments have been more dramatic than general enrollment declines, forcing many small schools to offer chemistry only on alternative years (Yager, Snider & Krajcik, 1988). Moreover, this is not a new phenomenon. Low chemistry enrollments have existed for more than a decade (Odell & Fifer, 1985; Boyer, 1983; Rakow, Welch & Hueftle, 1986).

Importance of Pre-High School Science Education

The problem of decreasing enrollments in chemistry is a complex one. In part, decline may be due to the high school chemistry curriculum and/or the quality of teaching at the high school level (Odell & Fifer, 1985). New curricula developed by The American Chemical Society and numerous institutes for high school teachers sponsored by the National Science Foundation, Dreyfus Institute, and others have recently addressed these issues. This is a beginning, but it is not the solution to the dilemma. Many high school science courses, especially chemistry, are elective subjects; therefore, a substantial proportion of students will not choose to enroll in them. This reality enhances the importance of pre-high school science education in the solution of this dilemma. For all students, elementary and middle school will be the period in which they receive an important exposure to science; for many it will be their terminal experience in chemistry.

Pre-high school education is often divided into elementary and middle levels. Both need to be examined. Researchers investigating the elementary level have found that very little science is taught and what is taught is often merely a reading of the textbook (American Chemical Society, 1983; Hurd, 1982;

Odell & Fifer,1985; Raizen & Jones, 1985). In further describing the elementary science experience, Pratt (1981) states, "Most often science is taught at the end of the day, if there is time, by a teacher who has little interest, experience or training to teach science". (p. 73) It is not surprising that educators have found the "turn off" to science occurs after the fourth grade (James & Smith, 1985; Schoenberger & Russel, 1986; National Science Board Commission on Precollege Education in Mathematics, Science and Technology, 1983; Hamm & Adams, 1989). This "turn-off" to science after the fourth grade targets the middle level education as the most critical level in regard to science and to chemistry knowledge in particular.

Students in grades six through eight receive more complex science content than in the elementary years (Boyer, 1983; Goodlad, 1984; Hamm & Adams, 1989). The teaching of chemistry and other science content during this period will provide knowledge and experience that students will use to make future decisions concerning science areas. Therefore, it is necessary to examine the context in which these experiences occur.

The Nature of the Emerging Middle School

The term middle school was rarely used in education prior to 1963 (Alexander, 1984). It does not only refer to school plant organization. Rather, it is a developing philosophy in education that focuses on the physiology, learning styles and behavior of the preadolescent (Alexander & George, 1981). School organization based on this philosophy is constructed around teams of three to five teachers that are responsible for the total education of a hundred or more students in an interdisciplinary approach. As a result these teachers are student specialists rather than content specialists (Alexander and George, 1981; Sale, 1979 ; Burrows, 1978). The number of middle schools in America has increased rapidly from 2,309 in 1972 to 7,641 in 1988 (Snyder, 1989). Therefore, it is important to examine their curricula as they relate to science education. The interdisciplinary nature of studies in this type of school extends between and within subject matter areas (Alexander & George, 1981). Publishers, such as Scott Foresman, Prentice Hall, Silver Burdett & Ginn, and Merrill, have attempted to address this trend by the general science texts that target those grades. Modular approaches have also been developed by teachers (Alexander & George, 1981). Both approaches require teachers to teach a variety of sciences, including chemistry, within a year. Yet there is no special training for these teachers (McEwen, 1984).

The middle school concept could lead to an undermining of teacher effectiveness in general at this level and particularly in the area of effective chemistry teaching in the sciences. The situation of a middle school teacher teaching chemistry in a general science curriculum may be analogous to the elementary teacher teaching science in the self-contained classroom. A national survey conducted by Weiss (1978) showed elementary teachers' perceptions about their qualifications for teaching science were consistent with the amount of time they spent teaching it. Analogously, middle school science teachers' beliefs about their ability to teach chemistry may influence the amount of time they spend teaching it in the general science curriculum.

The Role of Teacher Efficacy Belief Systems

Recent studies by Czerniak (1989) and Riggs (1988) found significant correlations ($r = .57$; $p < .01$) between teachers' self-efficacy, or belief in their ability to teach science, and their preference to teach science. Exploring the concept of teachers' efficacy belief systems could promote a better understanding of middle school science education.

Efficacy belief systems are grounded in social psychology, particularly social cognitive theory, and center around the concepts of self-efficacy and outcome expectancies. Self-efficacy, as developed by Bandura (1976), is a belief about one's ability to perform a particular behavior. This belief is the result of past experiences that can be used to predict future behavior.

Outcome expectancies, as proposed by Bandura (1976, 1981), are the anticipated results of behavior. These results are also based on previous life experiences. For behavior to be enacted both factors must be present. People must expect certain desirable outcomes, outcome expectancies, and they must believe in their own ability to perform the behaviors, self-efficacy. Bandura (1977, 1982) further states that when tasks are difficult and people are beset with problems, those with high self-efficacy will not only show more persistence but will also expend greater effort and have better focus on the task at hand.

In more recent work (Bandura, 1986) has placed a causal relationship between self-efficacy and outcome expectancy. He states, "Both outcome expectations and personal aspirations are dependent upon perceived self-efficacy " (p. 420). In other words the expected outcome of a behavior is determined by a person's belief in his or her capabilities to perform that behavior. For example, if people believe they can quit smoking, they will expect to be successful and will more likely realize their expectation.

External variables such as the lack of needed resources or extenuating circumstances can effect outcome expectancy (Bandura, 1986). Lack of resources hinders the execution of skills which results in a lowering of outcome expectations.

According to Bandura (1976, 1982, 1986), the self-efficacy/outcome expectancy theory is situation specific because it focuses on a particular behavior. It is possible to have high self-efficacy and positive outcome expectancies in one behavior, such as giving up smoking, but not to another behavior such as dieting. Therefore, researchers applying Bandura's theory to other disciplines need to focus on specific behaviors.

Teacher Efficacy as Linked to Teacher Behavior

In applying Bandura's theory to effective teaching behavior, Gibson and Dembro (1984) state that "teachers who believe student learning can be influenced by effective teaching (outcome expectancies) and who also have confidence in their own abilities (self-efficacy beliefs) should persist longer, provide a greater academic focus in the classroom and exhibit different types of feedback than teachers who have lower expectations concerning their ability to influence learning" (p. 570). These beliefs are called teacher efficacy beliefs and result from focusing Bandura's theory on the specific behavior of teaching.

General teaching effectiveness is a very broad area of focus. Recently researchers have found that teacher efficacy beliefs vary markedly across different teaching situations (Gutskey, 1986). An important aspect of the teaching situation is the content taught. Thus, many elementary teachers may have higher efficacy in teaching language arts than in teaching science, and some middle school teachers may have a higher efficacy in teaching biology than in teaching chemistry. The higher the grade level, the more narrow the content focus. This is reflected in the specific certifications for science content such as chemistry, geology or biology at the high school level. Researchers are beginning to develop instruments to address teacher efficacy beliefs in specific content areas. Riggs (1988) and Czerniak (1989) have constructed such instruments for elementary teachers who teach science.

PROBLEM STATEMENT

Middle school is the level at which students receive important experiences including more complex science content, particularly chemistry content, than they received in their elementary years (Boyer, 1983). Such experiences will contribute to students' scientific literacy and influence decisions about future enrollment in science courses. Since teacher self-efficacy and outcome expectancy were linked with teacher characteristics and behaviors (Ashton, Webb & Doda, 1983; Gibson & Dembro, 1984; Riggs, 1988; Czerniak, 1989), which themselves were linked to student achievement (Ashton, Webb & Doda, 1983; Gibson & Dembro, 1984;), it was necessary to examine middle school teachers' self-efficacy and outcome expectancy beliefs in science and chemistry teaching.

People's efficacy belief systems predict their behavior, but to alter behavior, efficacy beliefs need to be changed. In order to change people's efficacy beliefs, the factors that influence the development of efficacy must be determined (Bandura,1977, 1981, 1986). Therefore, it is important to investigate the factors that lead to the development of self-efficacy and outcome expectancy in middle school science teachers. According to Bandura (1977), a person develops both self-efficacy and outcome expectancy beliefs by cognitively processing past life experiences. In delineating experiences that could effect the specific nature of self-efficacy in science and chemistry teaching, three areas of focus emerge. These are: 1) work experience in science, especially chemistry; 2) teaching experience in science, especially chemistry; and 3) teacher science education, especially chemistry education because such experiences relate most directly to the act of science and chemistry teaching. The larger science self-efficacy framework may also influence the more specific nature of chemistry teaching self-efficacy.

Since teachers' expectations for student achievement often become reality, the factors influencing this belief system also need to be explored. Such factors would include a study of external variables related to the teaching act, individual student variables as well as student-family variables .

The researcher's purpose in this study was to test Bandura's theory of self-efficacy and outcome expectancy as it applies to science and chemistry teaching at the middle school level. To accomplish this, statistical path models were developed to examine the factors influencing science and chemistry self-efficacy and outcome expectancy.

THEORETICAL FRAMEWORK FOR THE STUDY

Bandura's theory provided the primary lens through which middle school teachers' efficacy beliefs systems were examined. The theory predicts the development of science teaching self-efficacy through experiences related to science and science teaching. Self-efficacy should result in specific teacher characteristics such as task orientation, effort and persistence. Teachers' outcome expectancies for student learning should also be influenced by their self-efficacy.

Several external variables can affect the self-efficacy/outcome expectancy system. Perceived self-efficacy will not result in action if the necessary resources to perform the behavior adequately are lacking (Bandura, 1986). When this concept is applied to teaching, it suggests that external variables such as lack of supplies, poor facilities, school policies and class size may not alter teaching self-efficacy, but they do hinder the teaching act and therefore lower the outcome expectancy of student learning.

The final outcome expectancy of teaching is student achievement. Bandura did not address outcome expectancies for tasks in which the perceived outcome is provided by another person such as the student. Outcome expectations that teachers have for students may be influenced by student variables such as actual performance (Gutskey, 1986), science background, motivation, attention span, behavior and discipline (Riggs, 1988; Gibson & Dembro, 1984) or by family variables such as background, value systems or home environments (Riggs, 1988; Gibson & Dembro, 1984). Therefore, these variables must be regarded as important factors that influence teachers' outcome expectancies.

Since the nature of experience is important to efficacy belief system development, middle school teachers must have specific experiences in chemistry and chemistry teaching. The unique nature of the materials and laboratory work make chemistry teaching different from other science teaching. Chemical substances often require specialized knowledge on the part of teachers (American Chemical Society, 1979, 1985; Flinn, 1989). Knowledge and experience with chemical substances gained through course work, specific teaching experiences, or other personal work experiences in chemistry will be especially important for the teacher to develop a positive chemistry teaching efficacy. The result should be more effort and persistence in the tasks related to the use of the chemicals necessary for teaching this subject matter, and also should result in positive chemistry teaching outcome expectancies.

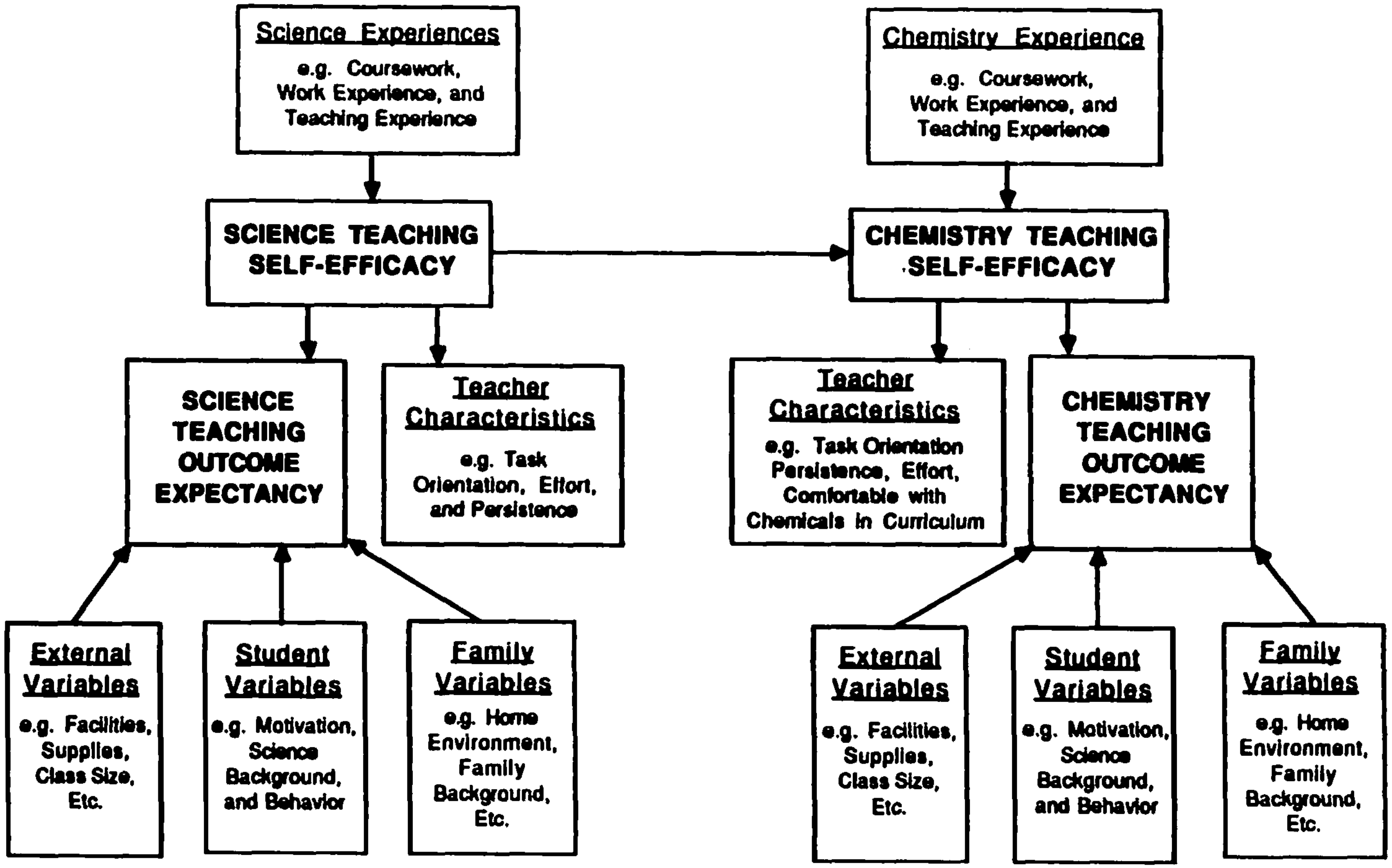
Chemistry teaching is a specialized component of science teaching. Therefore, self-efficacy in science teaching should influence self-efficacy in chemistry teaching. In a similar manner, student and family variables that affect science teaching outcome expectancy would also affect chemistry teaching outcome expectancy. A model that shows the interrelationship of these constructs is shown in Figure A.

SIGNIFICANCE OF THE STUDY

The results of this research should be of considerable interest to educators involved in middle school science education. Information on the antecedents of science teaching and chemistry teaching self-efficacy will help to delineate the type of coursework and experiences most helpful to the promotion of positive science teaching belief systems in teachers. Research results may be useful in determining science coursework recommended for middle school science teacher preservice and inservice education. Such information

Figure A

Factors Influencing Self-Efficacy and Outcome Expectancies in Science and Chemistry Teaching



can also be used by those developing middle school certification requirements at the state level.

This study should be of interest to researchers working in the field of teacher self-efficacy, as the results further delineate the specificity of teaching efficacy systems as they relate to content. Additionally, results should interest chemistry educators and chemists in their combined efforts to upgrade middle school chemistry education by providing a necessary focus on the middle school science teacher.

The results and conclusions could provide insight regarding the relationship between self-efficacy and outcome expectancy as they apply to middle school science. Information of this nature could assist researchers developing instruments to measure these factors.

The results of this research will provide information on teachers' perceptions of external variables that impede the teaching act. These findings could be of importance to school districts in planning facilities and budgets.

This work will add insight into teacher perceptions of student and family variables that influence teachers' expectations for student achievement. These findings could be important for teacher education in determining ways to help preservice and inservice teachers cope with these variables.

Finally, results could be important to middle school science teachers by providing information on their own belief systems and factors that affect them. Use of the instruments further developed in this study could help individual teachers focus on their personal belief systems as they relate to science and chemistry teaching.

DEFINITIONS

Belief - the acceptance or conviction that certain information is true or false. Belief is differentiated from attitude which is a negative or positive feeling about something.

Science Teaching Self-Efficacy (STSE) - a science teacher's belief in his/her ability to teach science.

Science Teaching Outcome Expectancy Beliefs (STOE)- a science teacher's expectations of students' achievement in science.

Chemistry Teaching Self-Efficacy (CTSE)- a science teacher's belief in his/her ability to teach chemistry.

Chemistry Teaching Outcome Expectancy Beliefs (CTOE) - a science teacher's expectations of students' achievement in chemistry.

Middle School - a school that contains grades 5-8 in any combination (most often grades 6-8), which has an interdisciplinary approach and focuses on the behavior and learning style of the pre-adolescent.

Science Coursework (SCW) - the combination of high school, college and graduate school courses in which science content other than chemistry was the primary focus.

Science Work Experience (SWE) - Job experience in science other than chemistry that is not related to teaching.

Science Laboratory Experience (SLE) - the combination of the laboratory components associated with science coursework (SCW).

Science Methods Coursework (SMC) - Education coursework related to the teaching of science.

Chemistry Coursework (CCW) - the combination of high school, college and graduate school courses taken by teachers in which chemistry content was the primary focus.

Chemistry Laboratory Experience (CLE) - the combination of the laboratory components associated with chemistry coursework.

Chemistry Work Experience (CWE) - Job experience in chemistry that is not related to teaching.

Science Teaching Experience (STE) - years in which science other than chemistry was the primary subject taught, and/or the mathematical product of the years of teaching experience and the percent of the year spent in science, but not chemistry teaching.

Chemistry Teaching Experience (CTE) - years in which chemistry was the primary subject taught and/or the mathematical product of the years of teaching experience and the percent of the year spent in chemistry teaching.

Science Workshop (W) - an institute, inservice experience or workshop in which teachers receive training in the teaching of science but not chemistry.

Chemistry Workshop (CW) - an institute, inservice experience or workshop in which inservice teachers receive training in teaching chemistry.

External Variable (EV) - a variable outside of the teachers' immediate control, such as poor facilities, lack of equipment, etc.

Student Variable (SV) - a personal student characteristic such as science background, motivation, performance, attention span, behavior and discipline.

Family Variable (FV) - a characteristic of a student's family such as background, values and home environment.

RESEARCH HYPOTHESES

1. The primary factors influencing science teaching self-efficacy (STSE) are science coursework (SCW), science laboratory experience (SLE), science work experience (SWE), science methods courses (SMC), science workshops (SW) and science teaching experience (STE).

2. The primary factors influencing science teaching outcome expectancy (STOE) are science teaching self-efficacy (STSE), external variables (EV), student variables (SV) and family variables (FV).

3. The primary factors influencing chemistry teaching self-efficacy (CTSE) are chemistry coursework (CCW), chemistry laboratory experience (CLE), chemistry work experience (CWE), chemistry workshops (CW) and

chemistry teaching experience (CTE) and science teaching self-efficacy (STSE).

4. The primary factors influencing chemistry teaching outcome expectancy (STOE) are chemistry teaching self-efficacy (CTSE), external variables (EV), student variables (SV) and family variables (FV).

5. Chemistry teaching self efficacy (CTSE) will be significantly lower than science teaching self-efficacy (STSE) for middle school teachers.

6. Chemistry teaching self-efficacy will influence teacher characteristics of effort, persistence, and task orientation.

7. Teachers with high science teaching self-efficacy (STSE) will prefer to teach science rather than other subjects.

8. Teachers with high chemistry teaching self-efficacy (CTSE) will prefer to teach chemistry over other science content areas.

ASSUMPTIONS

1. Responses of teachers to the instruments used to measure self-efficacy and outcome expectancy reflect their true beliefs in these areas.

2. Teachers' self-reports of background correctly portray their background.

3. Teachers' self-reports of characteristics related to chemistry teaching are accurate.

4. The tendency to make socially acceptable responses was controlled by assuring respondents of their anonymity.

5. Teachers' ratings of external, family and student variables represent their true perceptions.

6. Teachers in the district who responded to the study were not significantly different from those who did not respond.

7. The following logical requirements for inferring causality from the path analysis were met: All independent variables occurred prior to the dependent variables they influenced; True correlations existed between the independent and dependent variables; and that all common causes of the dependent variables were represented by the theory proposed.

LIMITATIONS

1. No method other than anonymity was used to control for the Hawthorne effect.

2. Teacher characteristics measured were those developed from Bandura's theory and do not represent all teacher characteristics.

3. The middle school science teachers in this study were teaching a general science curriculum.

4. The district in which the study occurred had recently changed organization and focus from junior high schools to middle schools.

5. The study was done with a sample size of 93 teachers.

DELIMITATIONS

1. This study was conducted in a large midwestern urban school district.

2. All data collected were from middle school teachers and middle schools with a 6-8 grade configuration.

SUMMARY

A study of science and chemistry teaching self-efficacy and outcome expectancies in middle school science teachers has been introduced in this chapter. A theoretical framework grounded in the theories of Bandura showed the interrelationship between self-efficacy/outcome expectancy and the factors of experience, external conditions, student and family variables. The significance of the study to teacher education, school districts and researchers was discussed. Terms pertinent to the study were defined and research hypotheses predicting the factors that determine self-efficacy and outcome expectancy in middle school science teachers were presented. The major delimitation of the study includes its population of midwestern urban teachers who teach a general science curriculum in grades 6-8.

CHAPTER 2

LITERATURE REVIEW

INTRODUCTION

Social cognitive theory provides the basis for the more in depth explanations of self-efficacy and outcome expectancy which are detailed in this chapter. Related concepts such as attitudes, self-concept and locus of control are compared to self-efficacy and outcome expectancy beliefs. Studies that apply these concepts to the development of efficacy in teaching are presented with an emphasis on the specificity of teacher efficacy belief systems. This is followed by the changing nature of science teaching in today's emerging middle school which places chemistry teaching in a unique position. This chapter ends with the presentation of a related study.

SOCIAL COGNITIVE THEORY

In social cognitive theory the explanation of human behavior must take into account the complexity of the human situation. Human behavior varies in different situations, toward different persons and at different times. Any theory used to explain it must assess all of these (Bandura, 1976). According to Bandura (1976): "People are neither driven by inner forces nor buffeted by environmental stimuli. Rather psychological functioning is explained in terms of a continuous reciprocal interaction of personal and environmental determinants." (p. 11) Through this interaction, people cognitively process data on how often their behaviors are reinforced over time and use this collective information to make judgments about future behavior. Determinations are made in areas of one's own abilities and the perceived outcomes of one's own actions in a particular situation. Through this process people exercise some control over the events that affect their lives (Bandura, 1986).

SELF-EFFICACY

Recent research in the 1970s and 1980s has highlighted the cognitive nature of behavior in order to better predict it. Beginning work was done in this area by Bandura (1976) who worked with phobics. The emerging theory of self-efficacy has demonstrated high predictive ability. It states that a specific belief about one's ability to perform particular behavior is a central determinant that can be used to predict the behavior itself. Self-efficacy is merely a belief in one's performance, not the actual outcome of the performance. According to Bandura (1981), it is a type of self referent thought that processes information about one's self and makes judgments about one's self-efficacy. Whether these judgments are accurate or faulty makes no difference in the way they predict behavior. It is the belief and not its accuracy that is important. People avoid activities that they believe exceed their abilities but undertake and perform assuredly those they deem themselves capable of doing. Bandura (1982) states further that:

> Judgments of self efficacy also determine how much effort people will expend and how long they will persist in the face of obstacles or aversive experiences. When beset with difficulties people who entertain serious doubts about their capabilities slacken their efforts or give up altogether, whereas those who have a strong sense of efficacy exert greater effort to master the challenge. (p.123)

People often do not behave optimally even though they know what to do because they do not believe they have the capabilities needed due to low self efficacy, and this self referent thought mediates the relationship between knowledge and action (Bandura, 1986). On the other hand, a strong sense of self-efficacy is an aid to good performance that helps in overcoming obstacles and uncertainties. Differences between individuals with low and high self-efficacy may be due to the fact that people with low self-efficacy dwell on their inadequacies and imagine obstacles to be more difficult than they really are, thereby creating stress and impairing performance by diverting energy from the task at hand (Bandura, 1981, 1986).

Perceived self-efficacy is also related to causal thinking. In seeking solutions to difficult problems, highly self-efficacious people are more likely to attribute their failures to insufficient effort or situational influences. Those with low self-efficacy attribute failure to deficient ability (Bandura, 1986).

Several studies have shown that measurements of self-efficacy can predict behavior. In a study of agoraphobics, measures of self-efficacy were found to correlate to performance attainments ($r = .74$; $p < .005$) and to predict the time and level of recovery (Bandura, Adams, Hardy & Howells, 1984). In a study performed by Condiotte and Lichtenstein and reported by Bandura (1982), "perceived self-regulatory efficacy predicted months later which participants would relapse, how soon they would relapse and even the specific situations in which they experienced their first slip" (p. 131).

Hill and Smith (1987) found both men's and women's computer efficacy beliefs predicted their use of computers. In another study, students' self-efficacy in mathematics contributed significantly ($p < .05$) to their choice of a college science major, but their actual mathematics performance showed no significant relationship to this choice (Hackett & Betz, 1982).

DEVELOPMENT OF SELF-EFFICACY

How does one gain a sense of self efficacy? According to Bandura (1976, 1977, 1981, 1986) self-efficacy is based on four sources of information. The most important source is performance accomplishments or actual personal mastery experiences. Repeated successes raise self-efficacy while failures, especially early in the learning process, lower it. After a strong self-efficacy has been established, the impact of failure is greatly reduced.

A second source is vicarious experience or seeing others who are perceived as being similar to oneself master a task. People persuade themselves that if others can do a task, they should be able to achieve similar results.

The third source is verbal persuasion. In this method people are encouraged to believe they have certain capabilities. Persuasion is often short lived if not followed quickly by personal mastery experience.

The fourth source is emotional arousal, a type of physiological state of tension and visceral arousal. People learn to judge their state of anxiety and vulnerability to stress from their physiological state. High arousal usually debilitates performance where moderate anxiety may enhance it.

OUTCOME EXPECTANCY

Self-efficacy is only one component of the cognitive processing of experience. The other component is outcome expectancy, which is "a person's estimate that a given behavior will lead to a certain outcome" (Bandura, 1977, p. 76) An outcome is the consequence of an act. It is not the act itself. Desired outcomes often motivate people to do particular tasks. Outcome expectancy can be visualized if one thinks of a dieter who restricts food intake and exercises regularly for the desired outcome of a new figure and better health. Behavior is related to the aggregate of its reinforcing outcomes. People do not respond to each momentary item of feedback as isolated experience. Rather they synthesize feedback information from sequences of events over long periods of time and in many different situations in order to make judgments about the outcomes of their actions (Bandura, 1976, 1986). For example, the outcome of a successful diet is not based on a single good day or an isolated eating binge but on weeks or months of restrictive eating.

Self-efficacy and outcome expectancies both result from cognitive processing but are quite different. According to Bandura, (1986):

> Perceived self-efficacy is a judgment of one's capability to accomplish a certain level of performance, whereas an outcome expectation is the judgment of the likely consequence such a behavior will produce. For example, the belief that one can high jump six feet is an efficacy judgment; the anticipated social recognition, applause, trophies, and self-satisfactions for such a performance constitute the outcome expectations (p. 391).

Other researchers agree that outcome expectancies are important. Maddux, Sherer & Rogers (1980) found that outcome expectancy manipulation influenced people's intentions to perform a behavior. Lee (1984) found both self-efficacy ($r = .73$, $p < .001$) and outcome expectancies ($r = .40$, $p<.007$) correlated significantly to performance in studying role playing in college students.

FACTORS INFLUENCING OUTCOME EXPECTANCY

Factors that influence outcome expectancy come from within the individual and from circumstances outside of the individual. Bandura (1986) states,

> ...the types of outcomes people anticipate depend largely on their judgments of how well they will be able to perform in given situations. Drivers who judge themselves inefficacious in navigating winding mountain roads will conjure up outcomes of wreckage and bodily injury, whereas those who are fully confident of their driving capabilities will anticipate sweeping vistas rather than tangled wreckage. ... In social, intellectual and physical pursuits, those who judge themselves high efficacious will expect favorable outcomes, self-doubters will expect mediocre performances and thus negative outcomes. (p. 392)

Therefore, according to Bandura, a primary determinant of outcome expectancy is self-efficacy.

Even when people have high self-efficacy, it is possible that outside variables can influence their outcome expectations. "When performances are impeded by disincentives, inadequate resources, or external constraints, self-judged efficacy will exceed the actual performance. When there are such discrepancies, it is not that people do not know their capabilities but that execution of their skills is hindered by external factors." (Bandura, 1986, p. 396) If the skill is hindered due to external variables, then the expected outcome is diminished.

RELATED CONCEPTS

Attitudes

Attitudes have long been considered to have cognitive, affective and behavioral components, but currently the major component is thought to be affective. (Shrigley, 1983; Koballa, 1988) An attitude is the affective result of information processing that ends in an individual's liking or not liking some object. In other words, an attitude is a feeling that results from thought.

A great number of studies have been done on the relationship of attitudes to behavior, but this approach has only been partially successful. According to Bandura (1986) failure is due to the fact that behavioral experiences alter attitudes. "Hence both attitudinal and behavior changes are best accomplished by creating conditions that foster the desired behavior. After people behave in new ways, their attitudes accommodate to their actions." (Bandura, 1986, p. 160) It should be noted that it is exceedingly difficult to induce behavioral changes that contradict entrenched attitudes and beliefs. Resistance to change shows a strong linkage between beliefs, feelings and behavior. Bandura (1986) indicates that the primary linkage is between beliefs and behaviors and that attitudes follow from these.

Self-Concept And Self-Esteem

Self-concept and self-esteem are both global traits that are derived from evaluative self-referent thought. Self-concept is a composite view of one's self that is derived from experience and from the evaluation of significant others. It contributes to how people develop attitudes toward themselves and how these attitudes may color one's outlook on life. Self-esteem pertains to the evaluations of self-worth. For peoples' actions to contribute to their self-esteem, those actions must be valued. A person may be an inept skier, and this ineptness is part of his/her self concept, but it will not effect his/her self esteem unless the person values skiing ability to determine his/her worth.

Both of these concepts are too global to be able to predict specific behaviors with anything more than a modest correlation (Bandura, 1986). In many cases the same self-concept can result in different actions. Self-efficacy beliefs are far more complex, allowing for different situations and different levels of behavior. The inept skier may still choose to ski if s/he perceives his/her capabilities to be good enough (high self-efficacy) to meet the challenge of the current conditions, which might be an easy slope on a good day.

Locus of Control

Locus of control refers to the degree to which individuals attribute the outcome of events to their own actions (Rotter, 1982; Phares, 1976). According to Frank (1981):

> The locus of control dimension may be viewed as a continuum that runs from the

> highly internal end to the highly external end. Internals believe that the outcomes of events are the results of their own actions, efforts or skills while externals attribute outcomes to factors outside of their control such as fate, luck or significant others. (p. 4)

To measure locus of control, Rotter (1982) developed a 29 item forced choice scale (I-E Scale). Examination of an item from this scale indicates the global nature of locus of control: "2. a. Many of the unhappy things in peoples lives are partly due to bad luck. b. People's misfortunes results from the mistakes they make" (p. 185). According to Rotter (1982) and Phares (1976) this test is a measure of generalized expectancy.

The internal-external perception of the cause of outcomes of personal actions is another type of universal personality trait. Lack of specificity is a major limitation in the use of the concept to predict behaviors in specific situations especially in the academic setting (Rotter, 1982).

According to Bandura (1986) the internal-external belief scheme of Rotter is primarily concerned with causal beliefs about the relationship between actions and outcomes and not with self-efficacy. It is an important distinction. Beliefs that outcomes are determined by one's own actions can be demoralizing or heartening depending on the level of self judged efficacy. " People who judge outcomes as personally determined but who lack the skills necessary would experience low self-efficacy and view the activities with a sense of futility" (Bandura, 1986, p. 413). Futility could result in "defensive externals" or people that arrive at an external locus of control as a defense against failure (Rotter, 1982).

Self-concept and self-esteem are more global than self-efficacy and locus of control is greater in dimension than outcome expectancies. The broader the concept the less predictability it has from one situation to another (Rotter, 1982). For this reason Bandura's constructs of self-efficacy and outcome expectancies should be the better predictors of specific behaviors such as chemistry teaching.

TEACHER EFFICACY

Efficacy theory has become an important construct in educational research. A teacher's sense of efficacy or teacher efficacy is the extent to which a teacher believes that he or she has the ability to effect student learning. Early research in this area was done by Rand Corporation researchers (Armor, Conry-Osequera, Cox, Kin, McDonnel, Pascal, Pauly and Zellman, 1976; Berman, McLaughlin, Bass, Pauly and Zellman, 1977). In these studies researchers measured teachers' sense of efficacy by totaling the score obtained from two Likert Scale items:

> 1. When it comes right down to it, a teacher can't really do much because most of a student's motivation and performance depends on his or her home environment.
>
> 2. If I really try hard, I can get through to even the most difficult of unmotivated students. (Berman et al., 1977, pp 159-160.)

The first item relates to outcome expectancy and focuses on the single external variable of "home environment". The second item refers to self-efficacy. Berman et al. (1977) found that teachers' sense of efficacy was positively related to the percentage of project goals achieved, amount of teacher change, continuation of both project goals achieved, amount of teacher change and improved student performance. Armour et al. (1976) reported that teachers with a greater sense of efficacy were more likely to have students achieving greater gains in reading.

This construct of teacher efficacy was further refined into a two component system (Ashton, Webb & Doda, 1983). The first was teacher efficacy, "which refers to teachers' beliefs about the relationship between teaching and learning" (p.2). Positive teacher efficacy means that students can and do learn what they are taught. This is analogous to outcome expectancy. The second component is " personal efficacy, the teachers' general sense of effectiveness as a teacher" (p. 2). Positive personal efficacy would state that "I can teach these students". This is analogous to self-efficacy. The integration of these two results in personal teaching efficacy, which is the best predictor of teacher characteristics.

Using these constructs, Ashton, Webb and Doda (1983) studied 48 middle school teachers in Florida. They measured personal teaching efficacy using items similar to the Rand Studies and followed this with structured classroom visitations and interviews. They reported:

> In brief we found that teachers' sense of efficacy was significantly related to student achievement as measured by Metropolitan Achievement test scores. ($r= .78$, $p <.003$) in mathematics classes and ($r= .83$, $p <.02$) in communications

> classes with students entering ability by holding constant the students' scores on the Metropolitan test from the previous year. In addition teachers' sense of efficacy was related to teacher and student behaviors that suggest that the teachers with a high sense of efficacy are more likely to be attentive to the individual needs of all students and to respond to the students in positive and accepting supportive style that encourages student enthusiasm and involvement in decision making. (p. 15)

These findings were confirmed by Gibson and Dembro (1984) in a study of 203 elementary teachers. These researchers constructed and validated a 30 item Likert scale instrument to measure teachers' personal efficacy and outcome expectancies in teaching. In developing items to measure outcome expectancy, Gibson and Dembro focused on external variables that related to the teaching situation such as school rules and policies. They also targeted the student's family situation such as home environment, family background, and family values as well student characteristics such as attention span, inappropriate student behavior and discipline.

After determining the teachers' level of total teaching efficacy, Gibson and Dembro randomly selected four teachers with high efficacy and four with low efficacy, then intensely studied these teachers through structured interviews and classroom visitations. They found teachers with low teaching efficacy used significantly more criticism (p. <.01) in responding to incorrect student responses and showed significantly less persistence (p <.01) in working with slower students than teachers with high teaching efficacy. Low efficacy teachers also showed less task orientation by spending significantly more time (p. <.01) in talk and activities not related to the teaching task at hand than did high efficacy teachers. These findings reflect Bandura's theory that self-efficacy in a particular task results in persistence and task orientation.

In reporting on the work of Ashton, Webb and Doda (1983) with middle school, junior high school and high school teachers, Ashton (1984) reported on some of the characteristics of high efficacy teachers. These teachers were confident of their ability to affect student learning; they assumed the responsibility to see that students learned, and they had positive expectations for student behavior and achievement. This finding confirms Bandura's theory that high self-efficacy will lead to capable performance and this will result in a high level of outcome expectancy.

The opposite end of the scale was also confirmed. Teachers with low efficacy expected their students to fail. They placed the responsibility for learning entirely on the student and not on their teaching (Ashton, 1984).

Riggs (1988) also found a significant correlation between self-efficacy and elementary teacher's self ratings of their science teaching ($r = .66$, $p < .01$). Significant correlations also were noted between teacher self-efficacy and outcome expectancy in these elementary science teachers ($r = .19$, $p <.01$). These findings also support Bandura's theory.

The measurement of personal teaching efficacy relates to what many researchers, teachers and administrators feel is "effective teaching". It also agrees with the literature on effective schools (Clark, Lotto & Astuto, 1984) and educational change (Fullan, 1982). Teachers with high teaching efficacy do consistently teach and demonstrate effort and persistence in the face of many educational changes. Therefore, in attempting to understand the school learning situation, it is important to assess teachers efficacy beliefs.

SPECIFICITY OF EFFICACY IN THE EDUCATIONAL SETTING

Within educational research, most studies of self-efficacy and outcome expectancy have focused on teaching in general. The information gained is very valuable but not very specific. In an attempt to further delineate these constructs, some researchers are focusing on more narrow areas, which is in full agreement with the theoretical constructs of Bandura (1977, 1986) which state that both self-efficacy and outcome expectancies are situationaly specific.

Hackett and Betz (1982) demonstrated that college students' mathematics self-efficacy could be measured and was beneficial to subject specific research. In this study mathematics self-efficacy was measured by students' indication of confidence in their ability to work mathematical problems and to achieve A or B grades in college courses dependent on mathematics ability. Their actual ability was measured by 18 questions from the areas of algebra, geometry and arithmetic. Mathematics self-efficacy, and not mathematics performance, contributed to the prediction of selection of science based college majors. Hackett and Betz interpreted their findings as supporting the concept of self-efficacy as a factor in educational and career choices.

Educational research on the area of teacher efficacy in specific subject matter areas is in its infancy. The work that has been done is in the area of elementary science teaching efficacy (Riggs, 1989; Czerniak, 1989). Both researchers focused on the idea that elementary teachers may have a high personal teaching efficacy but avoid teaching science due to a low personal efficacy in science teaching.

Riggs (1988) developed the Science Teaching Efficacy Belief Instrument (STEBI) to measure science teaching efficacy and found that teachers with low science teaching efficacy were significantly different than those with high science teaching efficacy in the following areas. Low efficacy teachers preferred not to teach science ($r = .51$, $p < .01$), spent less time teaching science ($r = .41$, $p < .01$) and did not use activity based teaching ($r = .35$, $p < .01$).

Czerniak (1989) found science teaching efficacy and anxiety toward science teaching to be negatively correlated ($r = -.53$, $p < .0004$). She also found that teachers with high science teaching efficacy use primarily indirect strategies and have greater confidence in their methods of teaching science than counterparts with low science teaching efficacy.

These researchers have shown that there is variation in elementary teachers' efficacies toward science teaching. This situationaly specific sense of efficacy results in different teacher behaviors. Therefore, in attempting to assess teachers efficacy beliefs, it is important to focus on the specific content taught.

MIDDLE SCHOOL SCIENCE TEACHERS

Middle school science teachers face the same dilemma as elementary teachers. They often teach more than one subject and within each of these subjects they are responsible to teach a variety of content areas (Alexander & George, 1981; Alexander, 1984). This change to an interdisciplinary curriculum and generalized approach is occurring at a time when schools appear to be downgrading science as a part of general education (Anderson, 1981). The growth of middle schools in America has not been paralleled by corresponding growth in teacher preparation for middle schools. McEwen (1984) states,

> ...middle schools are often staffed by those who are waiting to be 'promoted' to the senior high school and by elementary teachers waiting to be assigned to elementary schools. Since the prevailing attitude proclaims 'no

> specialized training needed' middle level teachers seldom seek additional training relating directly to the middle level. (p 109)

Seventy-two percent of middle schools report that only general inservice was required to change from elementary teaching to middle school teaching. This inservice focused primarily on philosophy and not content (Mc Ewen, 1984). It is not surprising that Ashton, Webb and Doda (1983) found that lack of subject matter knowledge was a major factor in determining middle school teachers efficacy toward teaching in general.

To date there is little research on middle school science teachers. In Gallager's (1986) review of science education literature, only three percent of the studies dealt with science teachers, and these were done on elementary and high school teachers. In the National Science Teachers Association report, What Research Says to the Science Teacher edited by Harms and Yeager (1981), there are sections dealing with elementary science and high school science but none on middle level science education. The critical nature of this lack of research is enhanced by the fact that middle schools are rapidly gaining in popularity.

Alexander (1984) reported Department of Education data showing 11,406 middle schools in 1983 when only 4,060 existed in 1977.

The primary information on middle school science curriculum comes from Alexander and George (1981). They indicate that this curriculum is often developed on the module approach by the teachers themselves. In listing the content of sixth through eighth grade modules from middle schools in Florida and Texas, only one module out of fifteen was chemistry in Florida and one out of nineteen was chemistry in Texas.

The small amount of chemistry taught may be related to the science course work taken by middle school teachers. The report of the American Chemical Society (1983) describes that most coursework done by K-8 teachers is in biology. This content background is reflected in the modules reported by Alexander and George (1981), which were half biological in content. According to Bandura (1977, 1986) to develop efficacy in a specific area such as teaching chemistry, a teacher must have experiences related to chemistry. Such experiences could only be gained through coursework in chemistry, science teaching methods courses that dealt with chemistry teaching, actual teaching experience in chemistry or possibly by working in chemistry related jobs. In order to understand the dearth of chemistry taught at the middle school, it is important to examine these antecedents and their relation to chemistry teaching efficacy of middle school science teachers.

CHEMISTRY TEACHER CHARACTERISTICS

The development of self-efficacy results in specific characteristics of effort, persistence and task orientation according to Bandura (1977, 1981). Researchers applying this theory to teaching situations in middle schools have confirmed these characteristics (Dembro & Gibson, 1985). If Bandura's theory is applied to subject specific teaching, it follows that chemistry experiences that develop self-efficacy in chemistry teaching should result in developing characteristics specific to that subject matter. Chemistry is a unique teaching area due to the nature of materials and laboratory work. Chemical substances often require specialized knowledge on the part of teachers in the areas of safety (American Chemical Society, 1979; Reese, 1979; Berberich & Nenadic, 1979; Swami & Singh, 1985), storage (American Chemical Society, 1985 ; Flinn, 1989), disposal (Mento, 1973) and preparation (Berberich, Howard, Stevens, Henderson, Ochs & Reed, 1984). These substances can invoke the emotional arousal discussed by Bandura (1981). In addition, chemistry experiments often require more teacher preparation and clean-up time (DiSpezio, Hall, Schraeder & Young, 1987), leading to more difficult and challenging situations for the teacher. The development of self-efficacy in chemistry teaching should result in teachers being comfortable with the use of chemicals in their curriculum. It should also produce teachers who are oriented toward the task of chemistry teaching in a general science curriculum and willing to expend the effort and persistence necessary to accomplish this task.

VARIABLES INFLUENCING OUTCOME EXPECTANCIES IN SCIENCE AND CHEMISTRY TEACHING

The expected outcome of teaching is student learning. When teachers **believe** that students can learn, they do indeed learn (Ashton, Webb & Doda, 1983). Gutskey (1986) also found that student performance was linked to teacher expectations of that performance. Teachers' outcome expectancies may be a key factor in student learning; therefore, it is important to attempt to delineate the variables that affect teachers' outcome expectancy.

According to Bandura, 1986, there is a causal relationship between self-efficacy and outcome expectancy in behaviors that center around a single person. Therefore, the development of self-efficacy in science and chemistry teaching is important for the attainment of positive outcome expectancy.

Due to the complex nature of the teaching act, many external variables could affect it and thus alter teachers' outcome expectancies. Examples of variables include facilities, supplies, equipment (Bandura, 1986), class size, school rules, district policies and community support (Gibson & Dembro, 1984). Because of the uniqueness of both the science and chemistry teaching situation with their need for equipment and supplies, it is possible that school science department leadership and district science support could also be important variables.

A RELATED STUDY

Czerniak (1989) researched the relationships among science teaching anxiety, science teaching self-efficacy, teacher educational variables and instructional strategies using data from 119 elementary teachers in Northwestern Ohio. The teachers responded by mail to the following instruments as reported by Czerniak (1989):

1. State - Trait Anxiety Indicator (STAI) developed by Spielberger. (State anxiety was general teaching

anxiety and science teaching anxiety; trait anxiety was general life anxiety.)

2. Teacher Efficacy Scale - modified from the Gibson and Dembro (1984) instrument by changing general teaching items into science teaching statements.

3. A pictorial questionnaire that showed different types of direct teaching strategies (lecture and textbook) and indirect teaching strategies (student experiments and group activities)

4. A questionnaire concerning teacher background including college courses taken, confidence, level of success and perceived value of those courses for elementary teaching.

Significant findings ($p < .0004$) included:

1. A negative relationship between teaching anxiety and science teaching efficacy ($r = -.53$);

2. A positive relationship between success in science courses ($r = .30$) and perceived value of science courses ($r = 17$) to science teaching;

3. A positive relationship ($r = .29$) between success in science courses and indirect teaching strategies;

4. A positive relationship ($r = .25$) between science teaching efficacy and indirect teaching strategies;

5. A negative relationship ($r = -.28$) between teaching anxiety and indirect teaching strategies;

6. A positive relationship (r=.25) between perceived value of instructional methods courses and indirect teaching strategies;

These findings indicate that science coursework and science teaching methods coursework are important prerequisites of science teaching efficacy and the use of indirect teaching strategies in elementary school teachers.

It is rational to assume that science coursework and science methods coursework would be even more important to the middle school teacher given the greater focus on content and the need for a more thorough understanding of science concepts at this more advanced level. It is also reasonable to hypothesize specialized experiences in chemistry (i.e. chemistry coursework and laboratory experience, chemistry teaching methods experience, chemistry work experience) are important antecedents to chemistry teaching efficacy for middle school teachers.

SUMMARY

Self-efficacy, which is a person's belief in his or her capabilities to perform a specific task, and outcome expectancy, which is a person's perceived outcome of that task have been shown to be important determinants of human behavior. They can be used to predict the level of task orientation, effort and persistence people will use when performing a particular task.

The development of self-efficacy occurs primarily through personal mastery experiences and vicarious experiences. Outcome expectancy is dependent on self-efficacy and on certain outside variables that can affect task performance.

When applied to teachers in the learning situation, self-efficacy is a teacher's belief in his or her ability to teach. Outcome expectancy is a teacher's expectation of student achievement. These constructs have been shown to predict certain teacher characteristics such as effort, persistence and task orientation.

Self-efficacy toward teaching a specific subject can be acquired through coursework, work experience and teaching experience in that subject. Outcome expectancy is dependent on self-efficacy and also on external variables that can impinge on the teaching act, such as poor facilities, lack of supplies or school policies. Student variables such as performance or motivation and family variables such as home environment can also effect the learning situation and alter teachers' outcome expectancies.

Work in the area of teachers' efficacy as it relates to subject matter is just beginning and, to date, only the science teaching efficacy of elementary teachers has been explored. Middle school teachers face similar content related decisions. It is important to explore middle school science teachers' efficacy systems toward specific science content areas such as chemistry in order to define content specificity as it relates to middle school teaching, to probe the antecedents that can promote science and chemistry teaching efficacy, and to better delineate the factors that influence teachers' expectations of student achievement at the middle level of education.

CHAPTER 3

METHODOLOGY

INTRODUCTION

This chapter begins with a discussion of the selection of instruments to measure science and chemistry teaching self-efficacies and outcome expectancies. Next, the development of the Background Questionnaire to assess teachers training and experience is explained. Third, construction of the Teaching Questionnaire to probe teacher characteristics and beliefs about the factors that affect student learning is presented. Methods for validating the questions and for data collection are then presented. Chapter three closes with the presentation of operational definitions and methods of data analysis.

INSTRUMENT SELECTION

A Measure of Science Teaching Efficacy

Two instruments were found in the literature that measure science teaching efficacy. One was a 30-item instrument developed by Czerniak (1989), who modified the general Teacher Efficacy instrument used by Gibson and Dembro (1984). The multiple authorship of the instrument resulted in a change from first person questions to third person questions. The exact reliability of this instrument when used by Czerniak (1989) is unclear, but all the instruments in her study were reported to have Cronbach alphas between .75 and .81. The theoretical constructs underlying this instrument relate more to the causes of efficacy than the measurement of efficacy.

Sorting from factor analysis divided the questions into internal and external variables. In addition, several items were ambiguous. For example, "If a teacher has adequate skills and motivation to teach science, she/he can get through to even the most difficult students" (p.71). Skills and motivation are clearly different. This instrument was not chosen for these reasons.

The second instrument, Science Teaching Efficacy Belief Instrument (STEBI), contains 25 items and was independently developed by Riggs (1988) from extensive work that began with an 80 item pool. The original item pool was narrowed to 43 items by a preliminary study involving 71 preservice elementary teachers and further narrowed to 25 items by a study involving 331 inservice elementary teachers. Content validity was established using a panel of five judges. Self reporting validity criteria were assessed using Pearson correlation coefficients on the following:

1. Years taught in elementary school
2. Choice of teaching science
3. Time spent teaching science
4. Utilization of activity based instruction
5. Self rating of effectiveness in science teaching
6. Teacher Preference as computed from the Subject Preference Inventory developed by Markle (1978).

The results are shown in Table 1.

Factor analysis confirmed the two-component scale, science teaching self-efficacy (Questions 2, 3, 5, 6, 8, 12, 17, 18, 19 21, 22, 23 and 24) and science teaching outcome expectancies (Questions, 1, 4, 7, 9, 10, 11, 13, 14, 15, 16 20 and 25) that had been predicted from the theoretical framework based on Bandura's theories. Eigenvalues for the self-efficacy scale and the outcome expectancy scale were 6.26 and 2.71 respectively. Cronbach alphas of .92 for the self efficacy scale and .71 for the outcome expectancy scale indicate excellent and adequate reliability respectively. For these reasons this instrument was chosen for the study.

Middle level teachers represent an extension of the K-6 population used by Riggs & Enochs (1990) and are not essentially different from it. Middle school teachers have a focus on students similar to that of elementary

Table 1

Validity Coefficients from Riggs (1989)*

(N = 305)

VALIDITY CTITERIA	STSE SCALE r	STOE SCALE r
Years Teaching Experience	.14 **	-.07
Choice of Teaching Science	.57 **	.08
Time Teaching Science	.41 **	.15 **
Use of Activity Based Teachin	.35 **	.03
Science Teaching Self Ratings	.66 **	.18 **
Subject Preference from SPI	.57 **	.12 *

Note. Table taken from Riggs (1988), p. 91.

* p < .06

** p < .01

teachers and also often teach more than one subject. (Ashton, Webb & Doda, 1983, Alexander & George, 1981).

A minor change in the STEBI was needed only in question 12, "I understand the science concepts well enough to be effective in teaching elementary science" (p.139). The word "elementary" was changed to "middle school" to provide the correct focus. See Appendix 1 for the complete STEBI that was used in this research.

A Measure of Chemistry Teaching Efficacy

An instrument to measure chemistry teaching self-efficacy STEBI-CHEM was developed by modifying the Riggs & Enochs (1990) instrument. The word "science" was changed to "chemistry" in items 5, 6, 12, 13, 17, 18, 19, 22, 23, 24, and 25. The word "science" was changed to "the chemistry section of science" in items 1, 4, 7, 8, 10, 11, 14, 15, 16, 19. The phrase "science teaching" was changed to "science teaching in chemistry" in item 21 (See Appendix 2). This provided the necessary focus on chemistry. No other parts of the items required modification because the factors associated with teaching chemistry in middle school are analogous to those for teaching science in the elementary school.

Similar techniques have been used in assessing other personality traits such as anxiety with the State-Trait Anxiety Instrument (STAI). In administering this instrument a brief paragraph is read to the subjects which asks them to focus on a particular situation. According to Katkin (1978), there is "voluminous research attesting to its reliability in a variety of contexts" (p. 1096). Dreger (1978) reports test-retest reliability for groups of high school juniors, college freshmen and psychology students to range from .83 to .92. Slight changes in populations and content focus do not seem to alter the reliability of this test.

Harty, Andersen and Enochs (1984) report changing the Attitude Survey for Junior High Science to administer it to upper elementary students by altering the reading level and finding reliabilities by the split half method of .83 on the adapted instrument.

The results of these investigations indicate that similar changes of population, words and situational focus not destroy the reliability and validity of the original instruments. At the heart of the issue of altering the original STEBI as well as the modifications that resulted in the STEBI-CHEM is the question of construct validity. Carmines and Zeller (1979) state the following: "It should be clear that the process of construct validity is by necessity theory-laden. It is impossible to 'validate' a measure of a concept in this sense unless there exists a theoretical network that surrounds the concept." (p. 23) The theoretical framework for the altered STEBI and STEBI-CHEM is essentially the same, except that focus is on middle school teachers and chemistry in a general science curriculum rather than elementary school teachers and science in a general curriculum. Construct validity lies in the logic of theory. Factor analysis does not determine validity, but confirms the theoretical construct (Carmines & Zeller, 1979). For these reasons the modified STEBI and STEBI-CHEM are believed to be valid and reliable instruments to access science and chemistry teaching efficacy in middle school teachers.

BACKGROUND QUESTIONNAIRE

The background questionnaire was based on Bandura's (1976, 1986) first three methods for building self-efficacy, including personal mastery, vicarious, and persuasive experiences. When applied to science and chemistry teaching, these types of experiences most likely occur in science or chemistry coursework, science or chemistry methods courses, science or chemistry related work experience, and science or chemistry teaching experience. Since effective science and chemistry teaching requires involving students in laboratory experiments, teachers most likely gain the skills needed for this by doing laboratory work themselves through their coursework. For this reason the background questionnaire asked teachers to indicate which of their high school and college science courses had laboratory components. In recent years many science institutes and workshops have been made available to teachers. Such professional development programs often stress laboratory activities, thereby providing teachers with personal mastery experiences in science and chemistry teaching. This questionnaire also asked about these experiences.

Personal mastery experiences in the teaching of science and chemistry are also gained through actual teaching experience. Teachers were asked to indicate their years of teaching and science teaching experience and to estimate the amount of their teaching time that has been spent in science and in chemistry teaching.

This questionnaire also asked about work experience, in science and chemistry, other than teaching. This type of personal mastery experience is important in the development of self-efficacy from a theoretical perspective.

The last item required teachers to indicate their teaching preferences as related to general subject matter and science content areas. In the development of the STEBI, Riggs and Enochs (1990) showed a moderate correlation ($r = .57$, $p < .001$) between teaching preference and science teaching efficacy for elementary teachers. This is in agreement with Bandura's (1986) theory that people confidently embark upon tasks which they believe they can do. Confirmation of these findings in middle school teachers was an additional method of cross checking. The entire background questionnaire that was distributed to teachers is found in Appendix 3.

TEACHING QUESTIONNAIRE

The teaching questionnaire probes four areas and is found in Appendix 4. The first area is related to the characteristics of effort, task orientation and persistence that Bandura (1976, 1977, 1986) indicates are evident in individuals with high self-efficacy toward a particular task. These characteristics were also found by Ashton, Webb and Doda (1983) when they studied teaching efficacy in middle school teachers.

Likert scale items (#1-4) were developed to elicit responses concerning task orientation toward chemistry, the degree of comfort felt with chemicals in the curriculum, effort needed to teach chemistry and the value of that effort.

Likert scale items were not deemed appropriate for assessing persistence due to the likelihood of socially acceptable responses by teachers (L. G.Enochs, personal communication, October 10, 1989). For the purposes of this study, persistence was assessed by the willingness of teachers to revise an experiment that fails. Persistence was assessed by an open ended question which read: If you found a "really neat" experiment to explain a chemistry concept to your students, but it failed when your students tried it, what would you do for the following year?

The researcher ranked responses using the following scale:

1. The response discussed revising the experiment and gave explanation.
2. The response simply stated "Revise it".
3. The response indicated turning it into a teacher demonstration.
4. The response stated that it should be done again with no changes or revisions.
5. The response was left blank.

First, all items were ranked. After a period of three weeks, ten questionnaires were randomly chosen, ranked again and the reliability determined.

The second area addressed in this questionnaire concerned external variables that can affect the teaching act and thus lower teachers' expectations for student achievement. The variables of facilities, supplies and equipment were drawn from Bandura (1986); community support, school rules, district policies and class size originated in the teacher efficacy instrument used by Gibson and Dembro (1984). The variables of district science coordination and school science coordination were variables of the district population being surveyed. Teachers were asked to respond by ranking the variables from 1-5 according to how each teacher perceived the variable influenced their science teaching and their teaching of the chemistry section of the curriculum in particular. (1 = Seriously Lacking; 2 = Moderately Lacking; 3 = No Effect; 4 = Moderately Favorable; 5 = Very Favorable) Space was left for teachers to add additional variables.

The third area of the questionnaire asked teachers about the influence of the family variables of home environment, family background and family values on student achievement. These variables were taken from the teacher efficacy instrument used by Gibson and Dembro (1984). The teachers were asked to rank the variables according to the extent they felt each of these affected their students' achievement in science and in the chemistry section of science. (1 = No Influence; 2 = Little Influence; 3 = Some Influence; 4 = Moderate Influence; 5 = Great influence) Space was provided for respondents to add other family variables they believed affected student performance.

The last part of this instrument asked about personal student variables of past student performance (Gutsky, 1986), student motivation (Riggs, 1988; Gibson & Dembro, 1984), science background (Riggs, 1988), attention span, behavior, and self discipline (Gibson & Dembro, 1984) that the teachers felt affected student achievement. Respondents were asked to rank these as they did family variables. Space was provided for them to add other variables.

VALIDATION OF QUESTIONNAIRES

The background and teaching questionnaires were examined by three science educators for content validity. Based on input from these individuals, the following changes were made. First, the phrase "prior to the 1989-90 school year" was added to better define the years of teaching experience. Second, to further quantify the area relating to coursework, the number of semesters was requested in lieu of the number of courses. Third, the item on persistence was changed to a short response item from a Likert scale item at this time. Lastly, the item on the amount of effort required to teach the chemistry area of the curriculum was added.

The resulting questionnaires, the STEBI and the STEBI-CHEM were completed by nine ninth grade teachers who had previously taught seventh or eighth grade science. Their only suggestion was to add a space for respondents to write the number of years of work experience before describing the type of that experience. They also indicated that it required an average of 30 minutes to complete all instruments.

The questionnaires were then examined by three teachers, including elementary and ninth grade teachers as well as professors in chemistry, science education and gifted education. These individuals suggested adding "grade level" rather than simply "level " when asking for the current years' assignment. This group also suggested the addition of the "year graduated from high school" to the Background Questionnaire.

DATA COLLECTION

The abovementioned instruments were distributed to middle school science teachers by the researcher at a district inservice meeting held on December 1, 1989. Seventy teachers were present and responded to the instruments at that time. Thirty-five were absent due to conflicting duties or personal reasons. Therefore, follow-up meetings were held at three locations within two weeks of the initial meeting. Eight additional teachers attended and completed the instruments at the followup meetings. The data collected from these 78 respondents were coded as Setting 1.

The 27 teachers not present at any of the meetings were telephoned at their homes or at school by the researcher in the first week of January. The project was explained in the same manner as it was at the district meetings, and each teacher was asked if he/she would participate. All responded favorably, and the instruments were mailed to teachers at their schools.

Ten teachers responded within two weeks by returning completed instruments by mail. The remaining seventeen teachers were sent reminder letters on January 23, 1990. Nine more teachers then returned their instruments. The remaining eight teachers were telephoned at their schools. Messages were left if they could not be personally contacted. One additional instrument was returned. The data collected from these 20 January participants were coded as Setting 2.

In all, 98 of 105 teachers responded. Five sets of data were very incomplete and were discarded. Three incomplete sets were due to teacher transfers or long-term illnesses. Therefore, the data analysis was performed with data from 93 middle school science teachers.

OPERATIONAL DEFINITIONS

Science Teaching Efficacy Belief Instrument (STEBI) - the instrument developed by Riggs (1988) to measure both science teaching self-efficacy and science teaching outcome expectancy via the use of two scales.

Science Teaching Efficacy Belief Instrument For Chemistry (STEBI-CHEM) - instrument developed by modifying the STEBI to measure chemistry self-teaching efficacy and chemistry teaching outcome expectancy by the use of two scales.

SESCALE - The value obtained from the composite of questions 2, 3, 5, 8, 12, 17, 18, 19, 21, 22, 23, and 24 on the STEBI that measures science teaching self-efficacy.

OESCALE - The value obtained from the composite of questions 1, 4, 7, 9, 10, 11, 13, 14, 15, 16, 20, and 25 from the STEBI that measures science teaching outcome expectancy.

SESCALEC - The value obtained from the composite of questions 2, 3, 5, 8, 12, 17, 18, 19, 21, 22, 23, and 24 on the STEBI-CHEM that measures chemistry teaching self-efficacy.

OESCALEC - The value obtained from the composite of questions 1, 4, 7, 9, 10, 11, 13, 14, 15, 16, 20, and 25 from the STEBI-CHEM that measures chemistry teaching outcome expectancy.

Science Coursework (SCW) - The value taken from the Background Questionnaire which was derived from the combination of high school, college and graduate coursework in all sciences except chemistry.

Science Work Experience (SWE) - The value taken from the Background Questionnaire which was derived from job experience(s) in science, other than teaching.

Science Laboratory Experience (SLE) - The value taken from the Background Questionnaire which was derived from the combination of laboratory experiences related to science coursework other than chemistry.

Science Methods Coursework (SMC) - The value derived from courses in science methods from the Background Questionnaire.

Chemistry Coursework (CCW) - The value taken from the Background Questionnaire which was derived from the combination of high school, college and graduate coursework in chemistry .

Chemistry Work Experience (CWE) - The value taken from the Background Questionnaire which was derived from job experience(s) in chemistry, other than teaching.

Chemistry Laboratory Experience (CLE) - The value taken from the Background Questionnaire which was derived from the combination of laboratory experiences related to chemistry coursework

Science Teaching Experience (STE) - Years in which science was the primary subject taught prior to the current year and/or the mathematical product of the years of teaching experience and the percent of the year spent in science teaching taken from the Background Questionnaire.

Chemistry Teaching Experience (CTE) - Years in which chemistry was the primary subject taught prior to the current year and/or the mathematical product of the years of teaching experience and the percent of the year spent in chemistry teaching taken from the Background Questionnaire.

Science Workshops (W)- The value taken from the Background Questionnaire which was obtained from the composite of institutes, inservice experiences, or workshops in which teachers are given training in science and /or the teaching of science excluding chemistry.

Chemistry Workshops (CW)- The value taken from the Background Questionnaire which was obtained from the composite of institutes, inservice experiences, or workshops in which teachers are given training in chemistry and /or the teaching of chemistry.

External Variables - The value taken from the composite of the ranking of external variables from question 6 of the Teaching Questionnaire.

Family Variables - The value taken from the composite of the ranking of family variables from question 7 of the Teaching Questionnaire.

Student Variables - The value taken from the composite of the ranking of student variables from question 8 of the Teaching Questionnaire.

Task Orientation in Chemistry - The value taken from Question 1 of the Teaching Questionnaire.

Chemical Comfort - The value taken from Question 1 of the Teaching Questionnaire.

Effort in Chemistry Teaching - The value taken from Question 3 of the Teaching Questionnaire.

Effort Value in Chemistry - The value taken from Question 4 of the Teaching Questionnaire.

Persistence in Chemistry Teaching - The value obtained from ranking the responses to Item 5 in the Teaching Questionnaire.

Preference to Teach Science - The value obtained from the analysis of the ranking of subject preferences from the Background Questionnaire.

Preference to Teach Chemistry - The value obtained from the analysis of the science content preferences from the Background Questionnaire.

Setting 1 - December meetings in which middle school science teachers were given time to complete the instruments of this study.

Setting 2 - At home or at school settings during January in which teachers completed the instruments of this study.

DATA ANALYSIS

Reliability and Validity of Instruments

Internal consistency reliabilities were determined for the STEBI and the STEBI-CHEM by computing Cronbach alphas. Construct validity was examined for both instruments using factor analysis.

Correlations

Pearson product-moment correlation analysis was done to assess the following:

1. Basic assumptions of the path analysis model, which state that significant correlations must exist between each dependent variable and its independent variables.

2. The relation of each chemistry teaching characteristic to chemistry teaching self-efficacy (CTSE)

3. The relation of subject matter preference to science teaching self-efficacy (STSE).

4. The relation of content preference to chemistry teaching self-efficacy (CTSE).

Frequency Distributions

Frequencies were analyzed for all variables within variable clusters such as external, student or family variables to regroup variables that were rated high from those rated low. Regrouping of variables was performed to avoid the cancelling out of ratings when responses were mathematically totalled.

T-Tests

T-tests were performed to compare the following:

1. Data from Setting 1 was compared to Setting 2 on all variables studied.

2. SESCALE was compared to SESCALEC.

3. External, Family and Student Variables in science were compared to the same variables in chemistry.

Path Analysis

Path analysis, a special case of structural equation modeling, was used to test the application of Bandura's theory to science teaching efficacy and chemistry teaching efficacy for middle school teachers. Path analysis was chosen because of the unique way it handles exogenous (independent) and endogenous (dependent) variables to infer causal relationships among them. The exogenous variables may be intercorrelated, but this is not a problem for this type of analysis (Land, 1969). The endogenous variable(s) is assumed to be determined by some linear combination of the variables in the system. According to Land (1969) this "allows a particular endogenous variable to be dependent on both exogenous and other endogenous variables in the system" (p. 6). Thus, path analysis provides a system to analyze the antecedents of science teaching and chemistry teaching self-efficacy and the influence of this self-efficacy on the outcome expectancy of student learning. Moreover, it permits analysis of the influence of external variables, student variables and family variables on outcome expectancy .

To date educational researchers have treated self-efficacy and outcome expectancy as separate endogenous variables (Armour et al, 1976; Berman et al; 1977; Ashton, Webb & Doda, 1983; Gibson & Dembro, 1984, Riggs & Enochs, 1990). Researchers have not attempted to determine the predicted causal relationship between self-efficacy and outcome expectancy suggested by Bandura (1986). Path analysis permits an examination of this causal relation while also studying the other external, family and student variables that may influence teachers' expectations of student achievement.

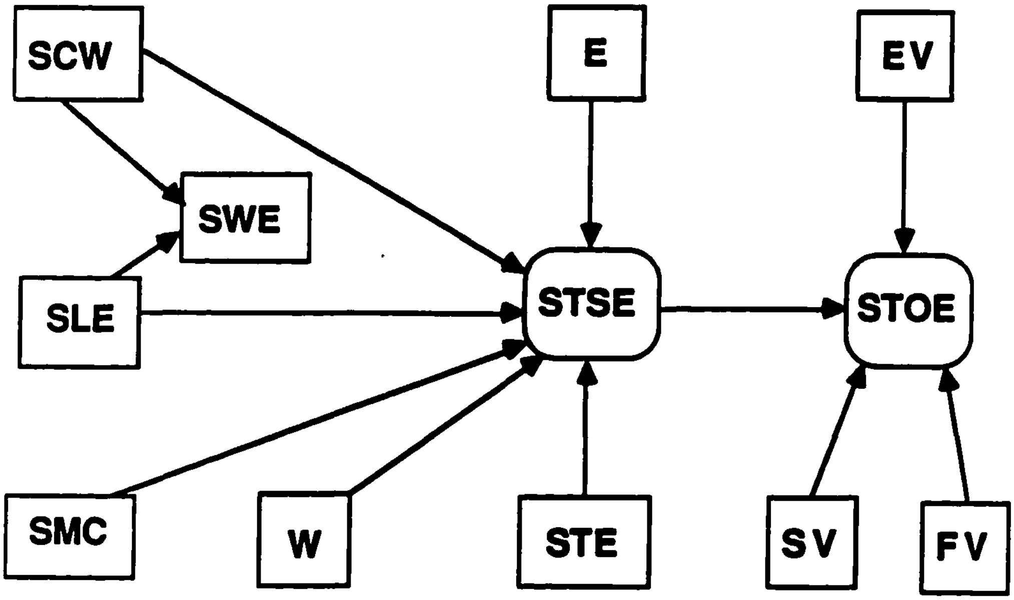
To date educational researchers have not attempted to determine the causes of teaching self-efficacy. According to Bandura (1986), self-efficacy is primarily developed through personal mastery experiences, secondarily through vicarious experiences, and lastly through persuasive experiences. For this research, teachers meet Bandura's criteria through their actual teaching experience in science and chemistry, work related experience, high school and college coursework, science methods courses and workshop or inservice experiences that focus on the teaching of science or chemistry.

This research was conducted to test Bandura's self-efficacy and outcome expectancy theory as it applies to science and chemistry teaching in middle school teachers. The researcher constructed two path models, one for science teaching and the other for chemistry teaching.

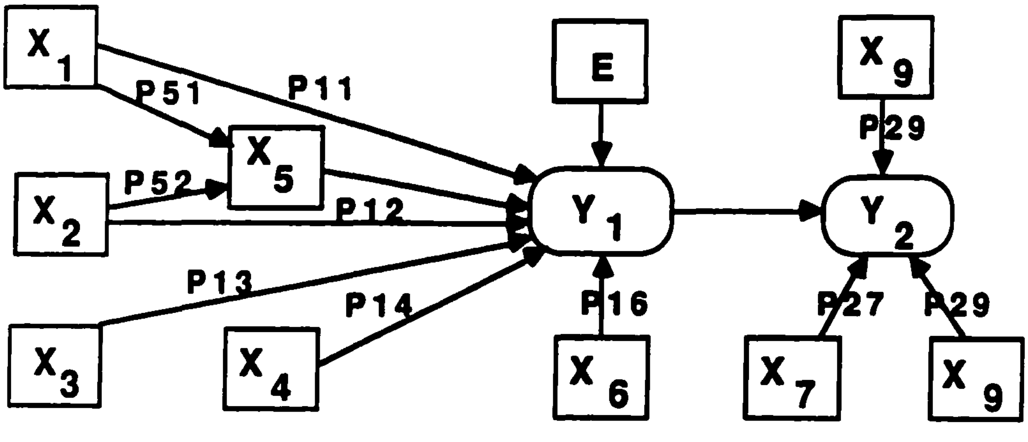
The first model (Figure B) shows how Science Coursework (SCW) and Science Laboratory Experience (SLE), influence Science Teaching Self-Efficacy (STSE) directly or indirectly through leading to Science Work Experience (SWE) which then influences Science Teaching

Figure B
Path Diagram for Science Teaching Self-Efficacy and Outcome Expectancy

Variables in the Path Diagram



Traditional Path Diagram



Self-Efficacy (STSE). Science Methods Courses (SMC), Workshops (W) and Science Teaching Experience also influence Science Teaching Self-Efficacy (STSE). Science Teaching Self-Efficacy (STSE) then becomes one of the exogenous variables along with External Variables (EV), Family Variables (FV) and Student Variables (SV) that influence Science Teaching Outcome Expectancy (STOE).

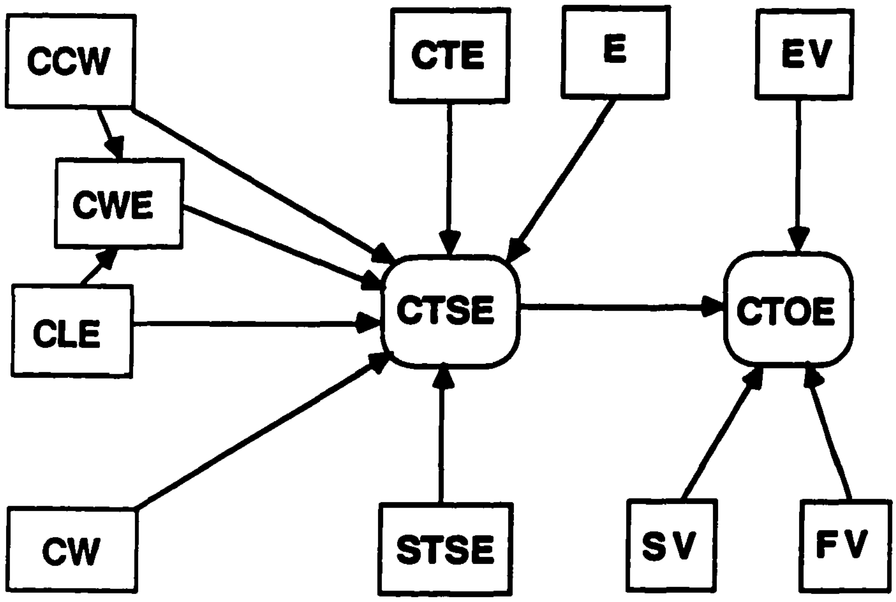
A traditional path diagram is presented in the lower half of Figure B. Straight lines with directional arrows infer a causal relationship. The paths to be analyzed are represented by the letter "p" followed by numbers referring to the endogenous and exogenous variables in that order. The path coefficients that result are equal to the beta weights or standardized partial regression coefficients from multiple regression analysis (Asher, 1976; Keith, 1988).

This diagram includes a latent variable, E, which was not analyzed in this research, but could affect Science Teaching Self-efficacy. It refers to personal variables such as mood (Bandura, 1986) or even religious factors that can have some effect on people's belief in their capabilities.

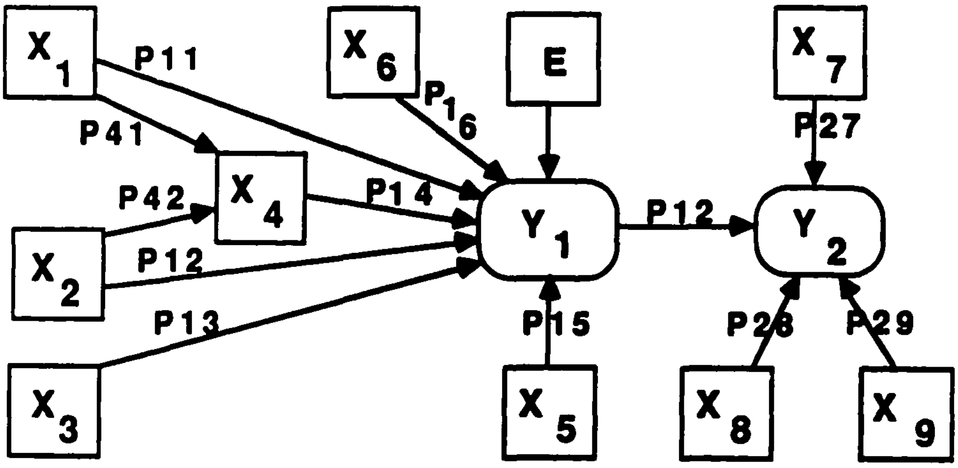
The second diagram (Figure C) refers to Chemistry Teaching Self-Efficacy (CTSE) and Chemistry Teaching

Figure C
Path Diagram for Chemistry Teaching Self-Efficacy and Outcome Expectancy

Variables in the Path Diagram



Traditional Path Diagram



Outcome Expectancy (CTOE). It is analogous to Figure B with the addition of Science Teaching Self-Efficacy as an exogenous variable to Chemistry Teaching Self-Efficacy. Chemistry teaching is a specialized area of science teaching and contains some similar experiences and skills. Self-efficacy in science teaching could influence the more specialized area of self-efficacy in chemistry teaching.

SUMMARY

The instruments used in this study were adapted from the STEBI (Riggs and Enochs, 1990) or developed based on the literature of self-efficacy and outcome expectancy as it was applied to middle school science teaching. Most of the teachers in a large midwestern urban school district completed these instruments at district inservice meetings. The rest were personally contacted by the researcher. The latter group received and returned the instruments through school mail.
The data were then analyzed by examining correlational matrices, frequency distributions and regression analyses to further develop the path models for science and chemistry teaching self-efficacy and outcome expectancy. T-tests were also performed to examine the differences in teachers' perceptions toward science and chemistry teaching.

CHAPTER 4

DATA ANALYSIS AND DISCUSSION

INTRODUCTION

This chapter begins with an analysis of the two different settings in which the instruments were completed. Reliability and factor analysis data for the STEBI and STEBI-CHEM are given along with supporting correlational studies that further establish validity. Presentation and discussion of correlational studies, frequency data and regression analyses follow to examine research hypotheses 1,2,3, and 4. The resulting path models for self-efficacy and outcome expectancy in both science teaching and chemistry teaching are presented. The researcher then used data to compare teachers' self-efficacy in science and chemistry teaching for the purpose of examining research hypothesis 5. Data correlating chemistry teaching self-efficacy to chemistry teaching characteristics are then introduced to test research hypothesis 6. Correlations of teachers' preferences for science and chemistry teaching with science and chemistry teaching self-efficacies are presented to examine research hypotheses 7 and 8. Post hoc analysis of science and chemistry teaching outcome expectancy is performed using multivariate analysis of variance.

SETTING ANALYSIS

Grouped t-tests were performed using SPSSX (Norusis, 1985) between setting 1 and setting 2. No significant ($p < .05$) differences were found on any variable used in subsequent analysis. As a result settings 1 and 2 were pooled and the analyses were carried out with 93 teachers. Demographics of this sample are given in Table 2.

INSTRUMENT ANALYSIS

STEBI

The reliability and factor analysis for both scales of this instrument were done using SPSSX (Norusis, 1985). Results show the alpha values of the SESCALE and OESCALE to be .88 and .80 respectively. The eigenvalue for the 13 item SESCALE was 5.2 while that for the 12 item OESCALE was somewhat lower at 3.5. These values compare favorably with the values reported by Riggs and Enochs (1990). The alphas and eigenvalues for the SESCALE are slightly lower in this study while the OESCALE is slightly higher on these measures than those reported by the above researchers. The preference to teach science also showed a moderate and significant correlation to SESCALE ($r=.42$, $p < .0001$). All of the above data provide evidence the STEBI is reliable and valid for use with middle school science teachers.

Table 2
Population Demographics

Variable	N	%
Gender		
Female	55	59.1
Male	38	40.9
Grade Taught		
Sixth	45	48.4
Seventh	23	24.7
Eighth	25	26.9
Years Taught Prior To 1989-90		
0	13	14.0
1-3	18	19.3
4-6	7	7.5
7-9	7	7.5
10-12	5	5.4
13-15	11	11.8
16-19	5	5.4
20-22	5	5.4
23-25	9	9.7
26-28	3	3.2
29-31	4	4.3
32-34	4	4.3
> 34	2	2.2
		100.0

Note. N = 93

STEBI-CHEM

Reliability analysis of the SESCALEC in the STEBI-CHEM produced an alpha coefficient of .94 with all thirteen items obtaining an item-total correlation of .53 or above. Factor analysis of this scale was done using SPSSX. Since the SESCALE and OESCALE did not show a significant correlation, a varimax rotation to simple structure was used. Convergence was attained in three iterations. Results shown in Table 3 indicate that all thirteen items loaded highly on Factor 1 and minimally on Factor 2. Thus the primary determinant of each item in this scale is Factor 1 only. Each item appears to measure only one theoretical dimension which has been previously defined as chemistry teaching self-efficacy. This scale also correlates to teachers' preference to teach chemistry over other content areas in science ($r=.55$, $p <.0001$) which supports the validity of this scale.

Reliability analysis of OESCALEC produced an alpha coefficient of .86. The lowest item-total correlation shown in Table 3 was .36 for Item 9. Factor analysis results showed all items loading highly on Factor 2 only. The single theoretical dimension identified was chemistry teaching outcome expectancy.

Table 3
STEBI-CHEM
Item-Total Correlations and Factor Loadings

Factor Loadings	Measure	I-T Co	Fact 1	Fact 2
SESCALEC	Item 2	.64	.66	-.02
Self-efficacy	Item 3	.71	.73	-.11
in Chemistry	Item 5	.88	.90	-.15
Teaching	Item 6	.53	.57	.11
	Item 8	.75	.79	.03
	Item 12	.67	.69	-.11
	Item 17	.72	.73	-.09
	Item 18	.82	.83	-.18
	Item 19	.83	.85	-.11
	Item 21	.64	.66	-.01
	Item 22	.78	.79	-.11
	Item 23	.74	.75	-.14
	Item 24	.62	.66	.11
Total Items = 13				
Total Scale Alpha = .94			Eigenvalue = 7.9	
OESCALEC	Item 1	.52	.06	.64
Outcome	Item 4	.61	.11	.73
Expectancy	Item 7	.59	-.40	.55
In Chemistry	Item 9	.36	-.02	.38
Teaching	Item 10	.57	-.29	.52
	Item 11	.48	.13	.58
	Item 13	.60	-.16	.61
	Item 14	.59	-.21	.63
	Item 15	.62	-.08	.69
	Item 16	.46	.12	.57
	Item 20	.58	-.05	.59
	Item 25	.56	-.11	.54
Total Items = 12				
Total Scale Alpha = .86			Eigenvalue = 4.1	

Note. N = 93

The results of the item analysis and correlational study for the STEBI-CHEM indicated that modification to narrow the focus to a particular content area in science was reasonable, as predicted by Bandura's theory. Modification produced a valid and reliable instrument for measuring chemistry teaching self-efficacy and outcome expectancy in middle school science teachers.

DESCRIPTIVE STATISTICS

Prior to the statistical examination of variables in this study it was noted that six individuals had science work experience, one individual had chemistry work experience and one individual had participated in a chemistry workshop. These variables had too few cases for the proposed analysis and were therefore dropped from further study (S.L. Benton, personal communication, March, 1990). The means and standard deviations of the remaining variables used in this study are found in Table 4. These descriptive statistics provided a background for the correlational and regression analyses used to test all research hypotheses and to develop the models for self-efficacy and outcome expectancy in science and chemistry teaching.

Table 4

Descriptive Statistics

Variable	Mean	Stan Dev
SESCALE	53.02	6.51
OESCALE	39.31	6.23
SESCALEC	43.02	7.11
OESCALEC	39.12	6.43
Yr. Science Teach Exp.	5.89	9.84
Yr. Chemistry Teach Exp.	0.18	0.22
Total Science Coursework (Sem)	13.33	8.15
Total Science Laboratory (Sem)	11.67	8.27
High School Science (Sem)	4.88	2.02
High School Science Lab (Sem)	4.20	2.10
College Science (Sem)	8.45	7.55
College Laboratory (Sem)	7.50	7.56
Science Methods Courses (Sem)	1.17	1.27
Science Methods Laboratory (Sem)	0.60	1.19
Science Workshops	0.29	0.71
Science Teaching Workshops	1.12	1.21

Table 4 Continued

Variable	Mean	Stan Dev
Total Chemistry Coursework (Sem)	3.11	3.16
Total Chemistry Laboratory (Sem)	2.99	3.10
High School Chemistry (Sem)	1.03	1.02
High School Laboratory (Sem)	0.99	1.04
College Chemistry (Sem)	2.08	2.65
College Chem. Laboratory (Sem)	2.00	2.67
Chemistry Workshops	0.02	0.15
Total External Variables (Sci)	33.09	8.51
Outside Variables (Sci)	7.06	2.33
Tot Ext. Var. Minus Outside Var.	26.02	7.03
District Coordination Science	3.94	1.27
Community Support (Sci)	3.13	1.38
Science Facilities	3.05	1.52
Science Supplies	2.58	1.36
Science Equipment	2.63	1.32
School Policies (Sci)	3.01	1.23
Class Size (Sci)	2.46	1.34
School Rules (Sci)	3.41	1.16
Class Scheduling (Sci)	2.72	1.14
School Coordination (Sci)	2.73	1.45
Textbook (Sci)	3.42	1.33

Table 4 Continued

Variable	Mean	Stan Dev
Total External Vatiables (Chem)	27.09	10.08
Outside Variables (Chem)	6.53	2.76
Tot Ext. Var. Minus Outside Var.	20.56	8.06
District Coordination (Chem)	3.62	1.55
Community Support (Chem)	2.90	1.53
Chemistry Facilities	2.48	1.61
Chemistry Supplies	2.38	1.46
Chemistry Equipment	2.39	1 48
School Policies (Chem)	2.78	1.36
Class Size (Chem)	2.30	1.43
School Rules (Chem)	3.16	1.41
Class Scheduling (Chem)	2.52	1.27
School Coordination (Chem)	2.73	1 45
Textbook (Chem)	2.86	1.60
Total Family Variables (Sci)	12.28	2.74
Home Environment (Sci)	4.19	1.04
Family Values (Sci)	3.99	1.06
Family Background (Sci)	4.10	0.98
Total Family Variables (Chem)	11.75	3.53
Home Environment (Chem)	4.08	1.25
Family Values (Chem)	3.75	1.36
Family Background (Chem)	3.92	1.24

Table 4 Continued

Variable	Mean	Stan Dev
Total Student Variables (Sci)	25.46	3.75
Science Background	3.83	1.13
Attention Span (Sci)	4.52	0.87
Motivatin (Sci)	4.72	0 56
Past Performance (Sci)	3.42	1.13
Behavior (Sci)	4.44	0.88
Self-discipline (Sci)	4.54	0.82
Total Student Variables (Chem)	24.88	5.95
Chemistry Background	3.76	1.34
Attention Span (Chem)	4.42	1 12
Motivation (Chem)	4.55	1.06
Past Performance (Chem)	3.40	1.25
Behavior (Chem)	4.38	1.12
Self-discipline (Chem)	4.38	1.22
Subject Preference (Science)	5.53	0.80
Content Preference (Chemistry)	3.25	1.57

Note. N = 93

ANALYSIS OF SCIENCE TEACHING SELF-EFFICACY AND OUTCOME EXPECTANCY

Correlational Analysis

Correlation matrices of variables associated with path analysis were studied for two reasons. First, correlations must exist between dependent and independent variables. Second, the type of regression used is based on the degree of correlation among the independent variables. Therefore, the researcher examined correlation matrices of all variables in this study. An extremely high correlation between science course work and science laboratory experience ($r = .98$, $p < .0005$) was found. As a result, only SLE was used for further analysis.

For the purpose of statistical testing, the revised research hypotheses were stated in null form. Research hypotheses 1,2,3 and 4 were tested twice. First, to establish the variables which will be entered into the regression analysis by testing which variables have significant ($p < .05$) positive correlations to SESCALE and OESCALE or to SESCALEC and OESCALEC. Second, to establish which positively correlated variables have significant ($p < .05$) Beta coefficients in the regression analysis and, therefore, belong in the path model. Correlational and regression analyses to establish the path model for science teaching self-efficacy and outcome expectancy were completed first. Correlational and regression analyses to establish the path model for chemistry teaching self-efficacy and outcome expectancy followed.

Correlational analysis was done using SPSSX (Norusis, 1985). A one tailed test of significance was performed on each entry.

Hypothesis 1: No significant ($p < .05$) correlations exist between science teaching self-efficacy, as measured by SESCALE, and science coursework with laboratory experience (SLE), science methods courses (SMC), science workshops (SW) or science teaching experience (STE).

Analyses showed correlations to SESCALE were as follows: SLE ($r=.43$, $p < .001$); STE ($r=.26$, $p < .007$); SMC ($r=.16$, $p < .06$) and W ($r=.11$, $p < .14$). Hypothesis 1 is rejected for SLE and STE but was not rejected for SMC and SW.

Hypothesis 2: No significant ($p < .05$) correlations exist between science teaching outcome expectancy, as measured by OESCALE, and science teaching self-efficacy as measured by SESCALE, external variables (EV), family variables (FV) or student variables (SV).

Analyses showed correlations to OESCALE were: SESCALE ($r= .08$, $p < .23$); EV ($r= .26$, $p <.005$); FV ($r= - .24$, $p <.01$) and SV, ($r= -.14$, $p <.09$). Hypothesis 2 is rejected for EV and FV but is not rejected for SESCALE and SV.

Discussion

The ultimate purpose of the analysis of science teaching self-efficacy and outcome expectancy was the development of a path model to determine the factors influencing these major variables. This development was an emergent process based on theory. Therefore, it was important to examine carefully the correlational analysis, particularly in the areas where relationships were not found as predicted by theory.

One possible reason that correlations between SESCALE and SMC or SW were not significant may be because 28% of these teachers did not take any science methods courses; 83% had had no science workshops; and 41% had had no science teaching workshops. This greatly reduced the variance in these areas and could have led to nonsignificant findings.

A plausible reason for the nonsignificant correlation between OESCALE and student variables in the initial analysis was found by studying frequency distributions. One of the variables in the student variable cluster shown in Figure D was student motivation. This variable was ranked as highly important to student learning by 99% of the teachers. Thus, student motivation was a constant, not a variable for this group of teachers. Similar results were found for attention span, behavior and self-discipline. These variables were ranked high by 90-93% of all teachers. All of these variables were removed from the student variables cluster and an additional correlation was performed between OESCALE and the new student variable grouping containing science background and past performance in science. A nonsignificant correlation ($r = -.09$, $p < .29$) was found. As a result, student variables were not entered into the regression equation.

The frequency distributions of the external variables were also studied. With the large number of variables in this cluster, summarized in Figure D, the possibility existed that some may have been ranked as favorable and others as unfavorable. Totaling the responses in this cluster potentially nullified the favorable and unfavorable effects. Moreover, such an effect did occur. District coordination was ranked very

Figure D
Variable Clusters

Initial External Variable Cluster

Facilities	Class size
Supplies	School Rules
Equipment	Student Scheduling
School Policies	Science Textbook
School Science Coordination	District Coordination *
	Community Support *

* Removed and placed in a separate cluster of External Support.

Initial Student Variable Cluster

Content Background	Behavior
Attention Span	Self Discipline
Past Performance	Motivation *

Removed due to lack of variance

Family Variable Cluster

Home Environment	Family Background
Family Values	

---

favorable by 73% of the teachers while 71% found community support favorable. These two variables also differed from the rest of the cluster because they represented influences outside the school. For the above reasons district coordination and community support were grouped in a separate cluster called Outside Support (OUTS). OUTS correlated to SESCALE ($r=.32$, $p < .001$) and to OESCALE ($r=.32$, $p <.001$). The remaining external variable cluster also correlated to SESCALE ($r=.28$, $p <.003$) and OESCALE ($r=.21$, $p <.02$). The new variables of OUTS and EV was used as independent variables for both SESCALE and OESCALE in the regression analysis.

The finding that external variables correlated to both self-efficacy and outcome expectancy scales can be explained by the nature and complexity of the science teaching act. Supplies, facilities, equipment, etc. were necessary for both teaching and learning. Lack of these could have influenced a teacher's sense of efficacy and expectancy for student learning.

A major finding of the correlational analysis was the absence of a significant ($p <.05$) correlation between self-efficacy and outcome expectancy. The middle school science teachers in this study appeared to believe that a teacher's ability to teach did not necessarily result in student learning if that student is unmotivated to learn, lacks self-discipline and attention, or is a behavioral problem. Therefore, the path between science teaching self-efficacy and outcome expectancy was removed from the path diagram. The result was that two separate models must be analyzed.

Path Analysis for Science Teaching Self-efficacy

The choice of a regression model in path analysis was based on the correlation among the independent variables. In this study, significant ($p < .05$) low to moderate correlations were found among the independent variables influencing SESCALE and OESCALE. Therefore, the effect of each exogenous variable on its respective endogenous variable must have included both direct and indirect effects. An examination of these effects can be accomplished through a system of simultaneous equations often referred to as multiequation or structural modeling (Hanusheck and Jackson, 1977). This type of regression analysis was done using the Sysreg procedure (SAS 1982; S. Oliver, personal communication, May 5, 1990).

Hypothesis testing of the path analysis models was done by restating Hypotheses 1 and 2 based on the correlational results.

Hypothesis 1a: No significant ($p < .05$) influence exists between STSE and SLE, OUTV, STE or EV.

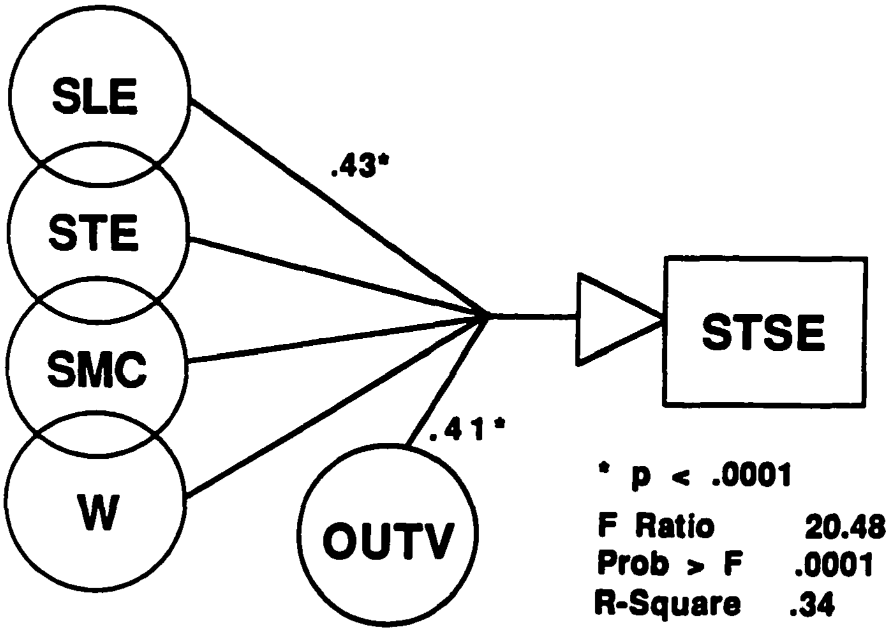
Beta Coefficients were: SLE (Beta = .43, $p < .0001$); OUTV (Beta = .41, $p < .0001$); STE (Beta = -.03, $p < .80$); EV (Beta = .27, $p < .08$). Hypothesis 1a was rejected for SLE and OUTV and was not rejected for STE and EV.

The path model for science teaching self-efficacy based on the results of this analysis is presented in Figure E. Interlocking circles indicate a low to moderate correlation between each of the two variables that are interlaced. Absence of a correlation is shown by independent circles.

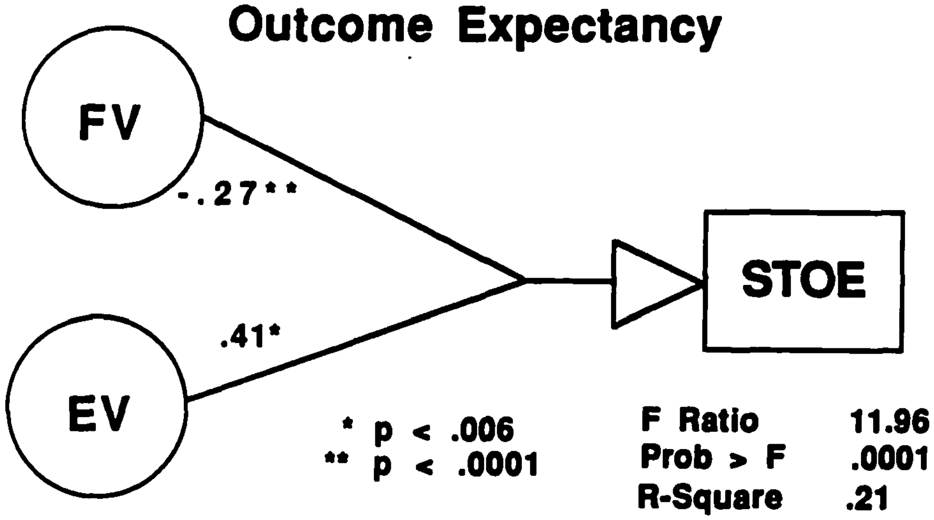
The path model accounted for 34% of the variance in science teaching self-efficacy as measured by SESCALE. The major influences were course work with laboratory experience, the outside variable cluster of community support and district coordination. Science methods courses and workshops remained in the model for theoretical reasons which state that personal mastery experiences are an important factor in producing self-efficacy (Bandura, 1983, 1986). However, science methods courses and workshops were not entered into the regression analysis because no significant correlation was found in the earlier analysis due to insufficient

Figure E
Path Models

Science Teaching Self-Efficacy



Science Teaching Outcome Expectancy



data (S. Oliver, personal communication, June 27, 1990).

The finding that the path coefficient for STE was not significant was more puzzling, especially since there was a significant correlation between STE and STSE ($r=.21$, $p <.007$). From a statistical perspective, the lack of significance indicated that the indirect effects of the covariance of SLE, SMC, OUTV and EV led to a diminishing of this relationship. A small sample size ($n = 93$) may also have played a role. From the theoretical point of view, it could have meant that these teachers have had both positive and negative experiences due to teaching different content areas of science, different students, or teaching in different buildings. Positive experiences increased self-efficacy while negative ones decreased it. Opposite experiences over time could have resulted in lowering teachers' self-efficacy.

The change to middle school from junior high school was another plausible reason. The majority of teachers in this study were former junior high school teachers who had focused on one content area such as physical science in the 7th grade or biology in the 8th grade. Beginning with the 1989-90 school year, all teachers were required to teach five science content areas including biology, chemistry, earth science, health and physics. Nearly all taught out of their area of expertise for some portion of the year. A lower science teaching self-efficacy could have possibly occurred for all, but especially for those who had taught in only one content area for a number of years, thereby leading to a lowering of science teaching self-efficacy for teachers with more teaching experience. This effect could be temporary in that self-efficacy could increase for these teachers after they gain expertise in teaching a variety of content areas. Due to this situation STE remained in the path model for theoretical reasons but no path coefficient was given (S. Oliver, personal communication, June 27, 1990).

The importance of district coordination and community support in influencing STSE was not hypothesized. Plausible explanations for this effect can be found by applying Bandura's theory to an examination of these factors within this district. The secondary science coordinator responsible for these teachers was an exceptionally supportive individual who knew all of these teachers. It was nearly impossible to interact with him without receiving some type of positive feedback. He encouraged these teachers and communicated to them the confidence he had in them. According to Bandura (1981, 1983) this type of persuasion increases self-efficacy. The science coordinator was a likely dominant influence in the OUTV cluster; however, many segments of the business community also interacted with science teachers in a similar manner through programs including classroom speakers, field trips and teacher internships. Business leaders in the community have organized a coalition which is actively involved in supporting local teachers, particularly science teachers through gifts of equipment and supplies, paid summer internships and support of local field trips. Even if teachers did not personally take part in any of the programs, their existence may have promoted positive feelings among this group of teachers.

Path Model for Science Teaching Outcome Expectancy

Hypothesis 2a : No significant ($p < .05$) influence exists between STOE and FV or EV.

Beta Coefficients were: FV (Beta = -.27, $p < .0001$); EV (Beta = .41, $p < .006$). Hypothesis 2a was rejected for both FV and EV

The path model for outcome expectancy, shown in Figure E, accounted for 21% of its variance as measured by OESCALE. External variables and family variables were major contributors as predicted.

Student variables, however, did not account for significant variance in this scale. This could have been due to the vast majority of teachers marking many of these variables as highly important, thereby decreasing the variability of the cluster. These student characteristics were so important that without them teachers did not believe their teaching can affect student learning.

ANALYSIS OF CHEMISTRY TEACHING SELF-EFFICACY AND OUTCOME EXPECTANCY

Correlational Studies

Initial examination of the data showed some similarities to the previous analysis. A high correlation ($r = .99$, $p < .0001$) was found between chemistry coursework (CCW) and chemistry laboratory experience (CLE); therefore, only the latter variable was used. District and community support for chemistry teaching were ranked high by greater than 80% of the teachers and were separated into an Outside Support Chemistry Cluster.

Hypothesis 3: No significant ($p < .05$) correlations exist between chemistry teaching self-efficacy as measured by SESCALEC and chemistry coursework with laboratory experience (CLE), chemistry teaching experience (CTE), science teaching self-efficacy (STSE) and the outside support chemistry cluster (OSCC).

Results showed correlations to SESCALEC were as follows: CLE ($r = .57$, $p < .0001$), CTE ($r = .45$, $p < .0001$), SESCALE ($r = .61$, $p < .0001$), and OSCC ($r = .18$, $p < .05$).

Hypothesis 3 was rejected for CLE, CTE, SESCALE, and OSCC.

Hypothesis 4: No significant ($p < .05$) correlations exist between chemistry teaching outcome expectancy (CTOE) and chemistry teaching self-efficacy (CTSE), external variables related to chemistry teaching (EV), student variables related to chemistry (SV), and family variables related to chemistry (FV).

Analyses showed correlations to OESCALEC were: CTSE ($r = -.11$, $p < .07$), EV ($r = .21$, $p < .03$), SV ($r = -.14$, $p < .05$), and FV, ($r = -.27$, $p < .005$). Hypothesis 4 was rejected for EV, SV and FV and is not rejected for CTSE.

Separate path models for chemistry teaching self-efficacy and chemistry teaching outcome expectancy were proposed due to the lack of significance between CTSE and CTOE.

Path Analysis Model for Chemistry Teaching Self-efficacy

Hypothesis testing of the path analysis models was done by restating Hypotheses 1 based on the information gained from the correlational studies and evaluating each hypothesis using the SAS (1982), SYSREG procedure.

Hypothesis 3a: No significant ($p <.05$) influence exists between CTSE and CLE, STSE, CTE or OSCC.

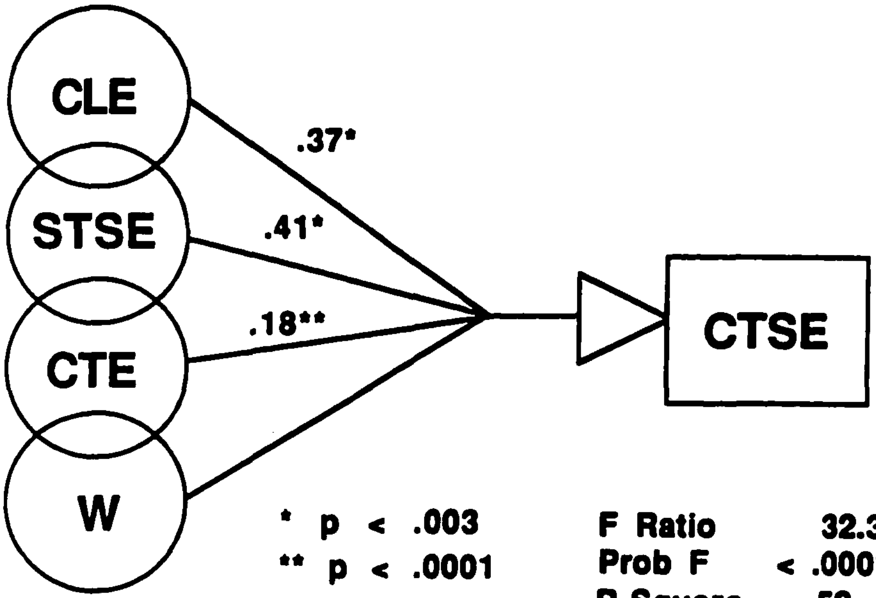
Beta Coefficients were: CLE (Beta = .37, $p <.0001$); STSE (Beta = .41, $P < .0001$); CTE (Beta = .18, $p <.03$) OSCC (Beta = .10, $p < .36$). Hypothesis 3a was rejected for CLE, STSE, CTE and was not rejected for OSCC.

The path model resulting from this hypothesis testing is shown in Figure F. This model accounted for 53% of the variance of chemistry teaching self-efficacy as measured by SESCALEC. The contributors were science teaching self-efficacy as measured by SESCALE, CTE and CLE. Workshops (W) remained in the path model but no path coefficient was shown due to insufficient data.

The observation that chemistry teaching experience was a significant influence in this analysis, while science teaching experience was not in the previous analysis, could possibly be explained by Bandura's theory. According to Bandura (1981, 1986) positive experience

Figure F
Plan Models

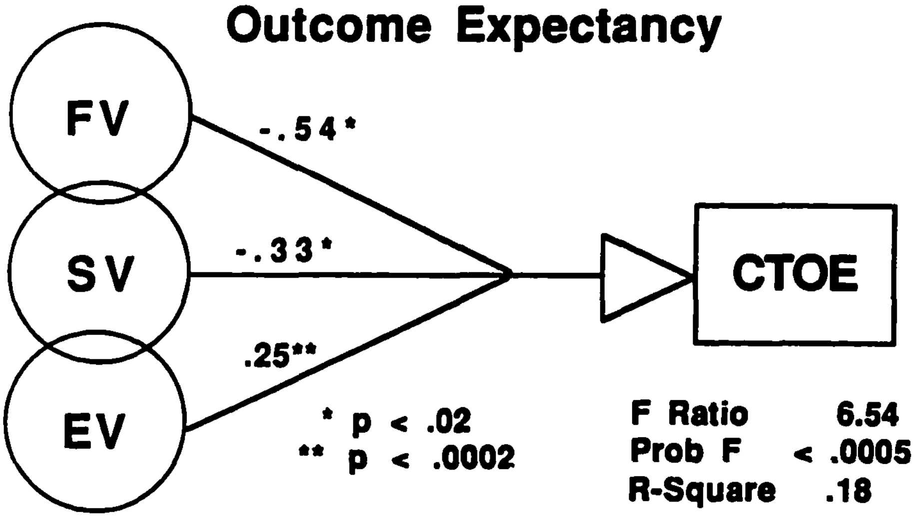
Chemistry Teaching Self-Efficacy



* $p < .003$
** $p < .0001$

F Ratio	32.34
Prob F	< .0001
R-Square	.52

Chemistry Teaching Outcome Expectancy



* $p < .02$
** $p < .0002$

F Ratio	6.54
Prob F	< .0005
R-Square	.18

increases self-efficacy whereas the opposite occurs for negative experiences. The teaching of science is a more global concept than the teaching of chemistry. It was possible that these teachers had varied experiences in the different content areas of science resulting in raising self-efficacy in some content areas but lowering it in others. This did not occur when teachers focused on one specific content area such as chemistry.

Path Analysis Model For Chemistry Teaching Outcome Expectancy

Hypothesis 4a: No significant ($p < .05$) influence will exist between CTOE and SV, FV and EV.

Beta Coefficients were: SV (Beta = -.33, $p <. 02$); FV (Beta = -.54, $p <.0001$); EV (Beta = .25. $p < .02$). Hypothesis 4a was rejected for SV, FV, and EV.

The path model resulting from this hypothesis testing is in Figure F and accounts for 18% of the variance in chemistry teaching outcome expectancy.
Family variables are the primary influencing factor followed by student and external variables.

DIFFERENCES IN SCIENCE AND CHEMISTRY TEACHING SELF-EFFICACY

Hypothesis 5: No significant difference exists between STSE and CTSE in middle school science teachers.

Evaluation of this hypothesis was done by the paired T-Test procedure in SPSSX (Norusis, 1985). Results showed SESCALE mean = 53.0, SESCALEC mean = 46.2; SESCALE standard deviation = 6.5, SESCALEC standard deviation = 10.0; T value = 8.4; P <.0005). Hypothesis 5 was rejected.

TEACHER CHARACTERISTICS AND CHEMISTRY TEACHING SELF-EFFICACY

Hypothesis 6: No significant (p <.05) positive correlation will be found between chemistry teaching self-efficacy, as measured by SESCALEC, and teacher characteristics of task orientation, comfort with chemicals, effort, effort value or persistence.

Correlations with one-tailed tests of significance were performed using SPSSX (Norusis, 1985). Findings are summarized in Table 5. Teachers with higher self-efficacy in chemistry teaching had significantly greater task orientation and comfort with chemicals. They did not believe teaching chemistry required more

Table 5

Correlations of Teacher Characteristics to Chemistry Teaching Self-efficacy

Variable	Sescalec	Prob
Task Orientation	.276	.004
Chemical Comfort	.633	.0005
Effort	-.340	.0005
Effort Value	.265	.005
Persistence	- .008	.468

Note. N = 93

effort than teaching other areas of science, and they believed the effort necessary was worth it. Hypothesis 6 was rejected for teacher characteristics of task orientation, comfort with chemicals, effort and effort value; it was not rejected for the teacher characteristic of persistence.

Though the intrarater reliability was 100% in ranking the responses to the item on persistence, no significant correlation was found between persistence and SESCALEC. This may have been due to respondents answering in socially acceptable ways, or to differing personality characteristics unrelated to this study.

SUBJECT AND CONTENT TEACHING PREFERENCES

Hypothesis 7: No significant ($p < .05$) positive correlation exists between teachers' self-efficacy in science teaching, as measured by SESCALE, and teachers' preference to teach the subject of science.

A correlation and one tailed test of significance was done using SPSSX (Norusis, 1985). Findings were; $r = .42$, $p < .0001$). Hypothesis 7 was rejected.

Hypothesis 8: No significant ($p < .05$) positive correlation exists between teachers' self-efficacy in chemistry teaching, as measured by SESCALEC, and teachers' preference to teach chemistry content.

A correlation and one tailed test of significance was done using SPSSX (Norusis, 1985). Findings were; $r = .55$, $p < .0001$). Hypothesis 8 was rejected.

POST HOC ANALYSIS

Differences in the path models shown Figures D and E for outcome expectancies in science versus chemistry teaching were not predicted by the researcher. To determine whether teachers in this study perceived outcome expectancies and the variables influencing it differently for science teaching than for chemistry teaching, a post hoc comparison was performed to test the following null hypothesis:

No significant difference ($p < .05$) exists between: OESCALE and OESCALEC, external variables (EV) in science teaching and EV in chemistry teaching, student variables (SV) in science teaching and SV in chemistry teaching, and family Variables (FV) science teaching and FV chemistry teaching.

A multivariate analysis of variance (MANOVA) using a within subjects design was performed by utilizing SPSSX (Norusis, 1985). To maintain a level of significance of $p < .05$ a modified Bonferroni Test was applied (Keppel, 1982). The desired significance level of .05 was divided by the number of comparisons (4), resulting in a level of significance for the test statistic of .01. The results of this analysis appear in Table 6.

The null hypothesis was accepted for OESCALE and OESCALEC and for FV in science teaching and FV in chemistry teaching based on the means and standard deviations in Table 4, the very small values of F, and their levels of significance as shown in Table 5. The null hypothesis was rejected for EV in science teaching and EV in chemistry teaching. Judgment was suspended for SV in science teaching and SV in chemistry teaching based in the method proposed by Keppel, 1982, whereby suspension of judgment was recommended when the alpha level falls between the level of significance corrected for familywise errors and the uncorrected level of significance. For this comparison of SV in science teaching and SV in chemistry teaching, judgment should be suspended for alpha levels between .01 and.05.

Since the external variable cluster contained a variety of variables, an attempt was made to determine which variables in the cluster were perceived differently for science than for chemistry teaching. The null hypothesis for these comparisons was as follows:

No significant difference ($p <.05$) exists between science teaching and chemistry teaching in the areas of

Table 6

MANOVA Analysis of Science Versus Chemistry
Outcome Expectancy

Variable	SS	DF	MS	F	Sig
Outcome Expectancy	2.84	1	2.84	.49	.48
Within Cell	529.66	92	5.75		
External Variables	1387.44	1	1387.44	78.2	.0005
Within Cell	1631.56	92	17.73		
Student Variables	23.42	1	23.42	4.67	.03
Within Cell	461.58	92	5.02		
Family Variables	.13	1	.13	.11	.74
Within Cell	111.34	92	1.21		

textbooks, school science coordination, student scheduling, class size, school policies, school rules, facilities, equipment, supplies, district coordination, or community support.

A multivariate analysis of variance (MANOVA) using a within subjects design was performed by utilizing SPSSX (Norusis, 1985). To maintain a level of significance of $p < .05$ a modified Bonferroni Test was applied (Keppel, 1982). The desired significance level of .05 was divided by the number of comparisons (11), resulting in a level of significance for the test statistic of .005. The results of this analysis are shown in Table 7.

The null hypothesis was rejected for textbooks and facilities and judgment was suspended for school science coordination, student scheduling, class size, school policies, school rules, equipment, supplies, district coordination, and community support.

SUMMARY

This chapter began with an analysis of the research setting that indicated no significant difference between the two groups of subjects that completed the instruments of the study at different times. The reliability and factor analysis data for the STEBI and

Table 7

MANOVA Analysis of Science Versus Chemistry External Variables

Variable	SS	DF	MS	F	Sig
Textbook	14.54	1	14.54	15.5	.0001
Within Cells	86.46	92	.94		
School Sci Cood	1.55	1	1.55	4.21	.04
Within Cells	33.95	92	.37		
Scheduling	1.94	1	1.94	6.04	.02
Within Cells	29.56	92	.32		
Class Size	1.21	1	1.21	4.4	.04
Within Cells	25.29	92	.27		
School Policies	2.37	1	2.37	8.04	.006
Within Cells	27.13	92	.29		
School Rules	2.84	1	2.84	6.95	.01
Within Cells	37.66	92	.41		
Facilities	15.10	1	15.10	31.3	.0001
Within Cells	44.40	92	.48		
Equipment	2.84	1	2.84	4.80	.03
Within Cells	54.66	92	.59		
Supplies	1.94	1	1.94	3.10	.08
Within Cells	57.56	92	.63		
Dist Coor.	4.52	1	4.52	9.06	.03
Within Cells	45.98	92	.50		
Comm Support	2.37	1	2.3 7	7.24	.008
Within Cells	30.13	92	.33		

STEBI-CHEM confirmed the validity and reliability of these instruments as used in this study. Correlational data, frequency distributions and regression analysis were presented which resulted in a reduction of the path analysis models. The lack of correlation between self-efficacy and outcome expectancy resulted in two separate models in each area. The findings of this study indicated that middle school science teachers have significantly lower self-efficacy in chemistry teaching than in science teaching. Correlations between chemistry teaching self-efficacy and teacher characteristics indicated that teachers high on SESCALEC had greater academic focus on chemistry, were more comfortable with chemicals, and believed that chemistry teaching took more effort than science teaching but the effort was well worth it. Teachers with high science teaching self-efficacy prefer to teach science over other subjects, and teachers with high chemistry teaching self-efficacy prefer to teach the content area of chemistry over other science content areas. Post hoc analysis indicated that teachers' perceived external variables of facilities and textbooks were more lacking in chemistry teaching than in science teaching.

CHAPTER 5

SUMMARY CONCLUSIONS AND RECOMMENDATIONS

INTRODUCTION

A study of middle school science teachers' self-efficacy and outcome expectancy beliefs toward science and chemistry teaching was undertaken for several reasons. First, the middle school level of science education is critical in introducing students to a variety of science content that will influence their future decisions for further science education, particularly in the area of chemistry. Middle level education is seen as crucial to the development of scientific and especially chemical literacy necessary to make decisions in today's chemically oriented society. Second, efficacy beliefs systems have shown high predictive ability. In particular, teacher efficacy belief systems are correlated to student achievement and to the teacher characteristics and behaviors associated with effective teaching (Ashton, Webb and Doda, 1983; Armour et al.,1976). In spite of these findings, no studies have been done to determine the variables that influence the development of science and chemistry teaching self-efficacy and outcome expectancy. Third, chemistry efficacy belief systems may be lower than science efficacy belief systems in middle school science teachers. A result of the current trend current trend toward teaching general or integrated science at this level could be an omission or reduction of chemistry from the curriculum, which would lead to lower chemical literacy in today's students.

This study was conducted to determine the variables influencing science and chemistry self-efficacy and outcome expectancy in middle school science teachers. Results of the study are summarized in this chapter. Conclusions are drawn and recommendations are made. Suggestions for future research are then presented and a final summation is given.

SUMMARY

Methodology

Examination of the literature described the foundation of self-efficacy and outcome expectancy beliefs as established in social cognitive psychology and subsequent educational studies. Experiences and other variables that influenced the development of these constructs were also determined. A theoretical framework and resultant path analysis models which were applicable to both science and chemistry teaching in middle school were constructed.

The literature also pointed to the changing nature of middle school science curricula which requires teachers to have expertise in a variety of science content without the concomitant education in these areas. Therefore, teacher efficacy beliefs related to teaching chemistry content may be different from those associated with science teaching in general.

A search was made for valid and reliable instruments to measure the constructs of self-efficacy and outcome expectancy beliefs as they related to science teaching. An instrument containing two separate scales that measured these constructs was found in the Science Teaching Efficacy Belief Instrument (STEBI) developed by Riggs (1989). The STEBI was modified to fit middle school science teaching. A second instrument, the Science Teaching Efficacy Belief Instrument for Chemistry (STEBI-CHEM), was adapted from the original STEBI.

The literature served as a foundation to develop two questionnaires that probed the variables influencing science and chemistry teaching self-efficacy and outcome expectancy. The first was the Background Questionnaire, which ascertained the kind and amount of teaching and work experience respondents had in science and chemistry as well as the number of semesters of coursework and laboratory experience each possessed in these two areas. Based on the work of Bandura (1981, 1986), each of these variables was thought to influence teacher self-efficacy. This questionnaire also requested respondents to rank their teaching preferences in regard to subject and content areas as a check on the validity of the STEBI and STEBI-CHEM instruments for this population in a manner similar to that used by Riggs and Enochs (1990).

The Teaching Questionnaire was used to determine the degree of influence certain external, student, and family variables had on their expectations for student learning. This questionnaire also attempted to assess respondents' chemistry teaching characteristics in task orientation, effort, persistence, and level of comfort with chemicals in their curriculum. Both questionnaires were validated by teachers and science educators.

This study was conducted by distributing the STEBI, STEBI-CHEM, Background Questionnaire and Teaching Questionnaire to middle school science teachers in a large urban midwestern school district. Most participants completed the instruments during district meetings; the remaining participants responded by school mail. Instruments from 93 out of a possible 105 teachers were studied. The primary data analyses were multiequation modeling. All data analyses were done after the deletion of variables such as work experience and student motivation for statistical reasons. Regrouping of the external variable cluster to isolate those that occurred within the school from those outside of school was also done. The differences between teachers' science and chemistry belief systems were then probed via t-tests and Manovas.

Results

Reliability, factor analysis and correlations of the SESCALE and SESCALEC to teachers' subject and content preferences confirmed that both the STEBI and the STEBI-CHEM were reliable and valid when used with this population.

Due to the lack of correlation between self-efficacy and outcome expectancy in both science and chemistry teaching, each of these path models was divided into a teaching self-efficacy model and an outcome expectancy model.

The primary variables influencing science teaching self-efficacy in this study were high school and college science courses with laboratory experience (Beta =.43, p <.0001) and outside support from district and community (Beta = .42, p <.0001). Coursework with laboratory experience and outside support variables explained 31% of the variance of science teaching self-efficacy. Variables influencing science outcome expectancy were external variables related to the school (Beta = .41, $p < .0001$) and family variables (Beta = -.27, $p < .006$). Together external and family variables determined 21% of the variance in science teaching outcome expectancy.

Chemistry teaching self-efficacy was influenced by science teaching self-efficacy (Beta = .42, $p <.0001$), high school and college chemistry courses with laboratory experience (Beta =.37, $p <.0001$) and chemistry teaching experience (Beta =.18, $p <.03$). Chemistry teaching self-efficacy, chemistry coursework with laboratory experience and chemistry teaching experience accounted for 52% of the variance. Outcome expectancy in chemistry teaching was affected by family variables (Beta = -.54, $p <.0002$), student variables (Beta = -.33, $p <.02$) and external variables relating to the school (Beta =.25, $p <.02$). Eighteen percent of the variance of chemistry teaching outcome expectancy was explained.

Middle school science teachers in this study had significantly ($p <.0005$) lower chemistry teaching self-efficacy than science teaching self-efficacy.

Teachers high in chemistry teaching self-efficacy did not believe that teaching chemistry in the middle school required more effort than teaching science. These teachers also had more task orientation toward chemistry teaching and comfort with the materials in the curriculum. They perceived the effort needed to teach chemistry as worthwhile and preferred it over other content areas.

Finding of a post hoc analysis showed that teachers in this study perceived external variables differently when applied to chemistry teaching than when applied to science teaching, particularly in the areas of facilities and textbooks.

CONCLUSIONS

1a. Science teaching self-efficacy does not influence science teaching outcome expectancy for the middle school teachers in this study.

1b. Chemistry teaching self-efficacy does not influence chemistry teaching outcome expectancy for the middle school teachers in this study.

2a. The path model in Figure E, which indicates that science coursework with laboratory experience and outside variables of district coordination and community support increase science teaching self-efficacy, is a valid model for explaining the 34% of the variance of science teaching self-efficacy for the middle school teachers in this study.

2b. Teachers with high science teaching outcome expectancy perceive external variables more favorably than teachers with low science teaching outcome expectancy. Teachers with high science teaching outcome expectancy believe that family variables have less influence on student learning than do teachers with low science teaching self-efficacy. The path model in Figure E is a valid model for explaining 21% of the variance of family variables and external variables on science teaching outcome expectancy.

3a. The path model in Figure F, which indicates that chemistry coursework with laboratory experience, chemistry teaching experience and science teaching self-efficacy increase chemistry teaching self-efficacy, is a valid model for explaining 52% of the variance of chemistry teaching self-efficacy for the middle school teachers in this study.

3b Teachers with high chemistry teaching outcome expectancy perceive external variables more favorably than teachers with low chemistry teaching outcome expectancy. Teachers with high chemistry teaching outcome expectancy believe that family variables and particular student variables of past performance and background in science have less influence on student learning than do teachers with low chemistry teaching outcome expectancy. The path model in Figure F is a valid model for explaining 18% of the variance of student variables, family variables and external variables on chemistry teaching outcome expectancy for the middle school teachers in this study.

4. Self-efficacy of the middle school science teachers in this study is specifically related to the content of science taught but not to the subject of science.

5a. Science coursework with laboratory experience exerts a significant influence on science teaching self-efficacy, whereas science teaching experience does not show a similar influence.

5b. Chemistry coursework with laboratory experience exerts a greater influence on chemistry teaching self-efficacy than does chemistry teaching experience.

6. Middle school science teachers in this study who have high chemistry teaching self-efficacy have characteristics important to high quality chemistry teaching, such as comfort with chemicals, task orientation to teaching chemistry and the belief that teaching chemistry does not require more effort than

teaching science and the belief that the effort needed to teach chemistry is well worth it.

7a. Middle school teachers in this study perceive external variables to be more lacking for chemistry teaching than for science teaching.

7b. Middle school teachers in this study perceive facilities and textbooks to be more lacking for chemistry teaching than for science teaching.

DISCUSSION

Bandura's theory provides a framework for probing the determinants of teaching self-efficacy, particularly if the specific nature of the content being taught in taken into account. The role of personal mastery experiences and vicarious experiences in the development of self-efficacy, as explained by Bandura (1983, 1986), can be partially translated into coursework and teaching experience for middle school science teachers. Coursework with a laboratory component is a more important determinant of teaching self-efficacy than is teaching experience. A plausible explanation may be that coursework is viewed as a more positive experience than actual teaching.

Bandura (1983,1986) also states that self-efficacy can be established and increased by verbal persuasion. The influence of positive interaction from the science coordinator and community on science teaching self-efficacy supports the importance of positive reinforcement in the development of teaching self-efficacy.

Variables influencing teachers' expectations for student learning are more difficult to determine than variables influencing teachers' self-efficacy, as shown by the smaller percentages of explained variance in the outcome expectancy models than in the self-efficacy models. External variables such as facilities, supplies, school policies, textbooks, etc., play a significant role in teachers' outcome expectancies as predicted by Bandura's theory. Teachers' perceptions of other variables that center around the student's family such as home environment, family values and family background are better predictors of teachers' outcome expectancies than are student variables which include past performance, attention span, behavior, self-discipline, and background.

All teachers in this study ranked student motivation as having a high influence on student learning. Therefore, student motivation is not a variable influencing student learning but a condition teachers believe must be present for student learning to occur in middle school science.

The finding that science teaching self-efficacy is significantly different from chemistry teaching self-efficacy for the middle school science teachers in this study confirms the situationally specific nature of self-efficacy as explained by Bandura (1986). Therefore, both the theory of self-efficacy and the findings of this study indicate that the determination of teachers' self-efficacy beliefs in middle school science teaching should be content specific.

Scores on chemistry teaching self-efficacy (SESCALEC) do have a moderate ability to predict teacher characteristics related to chemistry teaching as indicated by Bandura's theory. These were summarized in Table 4. The more specifically the characteristic relates to chemistry teaching, the higher the predictive ability. Comfort with chemicals ($r = .63$) has a high and more significant ($p < .0005$) correlation to chemistry teaching self-efficacy than does the more general concept of task orientation ($r = .276$, $p < .004$). Therefore, the situationally specific nature of self-efficacy must be taken into account when making predictions concerning teacher characteristics based on teachers' self-efficacy.

The specificity of chemistry teaching in a general science curriculum is also evident from the finding that the middle school science teachers in this study view identical external variables, particularly facilities and textbooks, differently when these variables were associated with the teaching of chemistry content than when they are associated with the teaching of general science content. These differences were predicted by the researcher based Bandura's theory and the unique requirements of chemistry teaching (American Chemical Society, 1979; Reese, 1979; Berberich and Nenadic, 1979; Swami & Singh, 1985; Flinn, 1989; Mento, 1973; Berberich, Howard, Stevens, Henderson, Ochs & Reed, 1984; DiSpezio, Hall, Schraeder & Young, 1987). Therefore, the needs of teaching chemistry content in middle school are unique from the needs of teaching general science content. These unique needs must be met in order to insure that chemistry content is not omitted or reduced in middle school science courses.

SIGNIFICANCE

The lack of a significant relationship between self-efficacy and outcome expectancy in middle school science teachers, even though partially explained by Bandura's theory, has important implications for middle school science education. Studies by the Rand Corporation (Armour et al.,1976) and by Riggs and Enochs (1990) found low to moderate correlations between self-efficacy and outcome expectancy in elementary teachers, indicating that teachers assumed some of the responsibility for student learning by the way they taught. The absence of this finding in middle school teachers and their perceptions of the great influence of student variables such as motivation, behavior and attention span indicates they have shifted much of the responsibility for learning onto the student. Students' family backgrounds and external variables in the teaching situations had more influence on student learning than did teaching. In short, teachers did not believe their teaching influenced student learning. Studies (Ashton, Webb and Doda, 1983; Edmunds, 1979) have shown that effective teachers claim some of the responsibility for student learning; the finding that these teachers did not assume this responsibility may provide insight into some current problems. At the district level, teachers' failure to accept the responsibility for student learning may have a bearing on the large number of below average grades that occurred in science. On a national scale, teachers' failure to accept the responsibility for student learning may provide a partial answer for the "turn-off" to science that is reported to occur after the fifth grade.

The finding that science and chemistry coursework with laboratory components had a greater influence on teaching self-efficacy than teaching experience is encouraging, because coursework is more easily acquired than experience. It supports the importance of these types of courses in teacher and continuing education.

The finding that chemistry teaching self-efficacy was significantly lower than science teaching self-efficacy in middle school teachers involved in a general science curriculum is significant for science and chemistry education as well as for school districts. One current trend in science education calls for an integration of science content areas in the teaching of science through high school (Aldridge, 1989). Districts, such as the one in which this study was conducted, support the basic philosophy of this approach and have begun to implement integrated science in their middle schools. However,the backgrounds of the teachers are not commensurate with their current responsibilities. Most have content specialties other than chemistry and prefer to teach in those areas. Few have a background in all sciences they are expected to teach. Without a positive belief in their abilities to teach in all of these areas, especially in chemistry, these areas will be slighted, causing students to have very little exposure to chemistry and perhaps other areas of science throughout their middle school experience. The result will be a lowering of scientific and chemistry literacy at a time when literacy in both areas is crucial.

The discovery that middle school science teachers consider external variables, particularly facilities and textbooks, as more lacking when related to teaching chemistry than teaching science speaks to the implementation of general science programs in middle school. External variables need to be adjusted to meet the needs of teaching chemistry to prevent the lowering of teachers' outcome expectancies in this specialized content area.

RECOMMENDATIONS

General Applications

The conclusion that chemistry teaching self-efficacy is different from science teaching self-efficacy and is developed by course work with laboratory experience points to the need for middle level certification in science that addresses the general science curriculum. This certification should require coursework and laboratory experiences in chemistry commensurate with those in other science content areas. School districts should require this type of certification for their teachers prior to the adoption of a general science curriculum in their middle schools.

Colleges and universities that are involved with science teacher education should develop programs that target middle level science teachers' efficacy belief systems. Institutions of higher education should aim to increase teachers' self-efficacy in science, and particularly chemistry teaching, through coursework and laboratory experience in these areas. Colleges and universities should increase teachers' outcome expectancies for student learning by stressing the relationship between teaching and learning, and the relationship between teachers' expectations of student learning and students' actual achievement. Institutions of higher education also should provide instruction that will help teachers increase student motivation.

Middle school administrators should receive training in teacher efficacy belief systems, science education and the special needs of chemistry education. These administrators should become aware of the importance that external factors have in the development of teachers' beliefs for student learning. Administrators control such factors as school policy and rules, class size, student scheduling, and the use of facilities; therefore, they must accept some of the responsibility for teachers' expectations for student learning.

District Based Applications

Teachers in the district studied overwhelmingly believe that student motivation is a necessary condition for student learning in middle school science. Therefore, it is recommended that teachers in this study receive inservice training in two areas. First, they should receive training in methods to improve student motivation. Second, they should be presented with a variety of methods, other than paper and pencil tests, to assess student learning. The latter recommendation is made to broaden the spectrum by which teachers assess student learning so that the teachers will have a more positive feedback as to their teaching. Students' successes should lead to raising teachers' self-efficacy by providing teachers with positive personal mastery experiences in science and chemistry teaching.

Teachers in this district varied their expectations for student learning based on their perceptions of family variables such as home environment, family background and family values. Teacher inservice should be aimed at increasing teachers expectations for student learning regardless of perceived family variables.

Middle school teachers in this district exhibited significantly lower chemistry teaching self-efficacy than science teaching self-efficacy. Based on the path model for the development of chemistry teaching self-efficacy, this deficiency can be improved by providing coursework with laboratory experience. Teacher training is a positive approach to increasing chemistry teaching self-efficacy. In-district training also would allow teachers to interact and exchange ideas with their peers. This kind of activity can raise self-efficacy (Bandura, 1983).

The path model for science teaching self-efficacy showed the significant influence of outside variables which included the district science coordinator and community support. Therefore, it is recommended that central administration maintain a district science coordinator that provides positive interaction with science teachers, and continue cooperative community efforts.

External variables such as facilities, equipment, school rules, student scheduling and school policies were found to significantly influence teachers outcome expectancies. These variables are the responsibility of school administrators. Therefore, it is recommended that school administrators be trained in teacher efficacy belief systems and in the supportive role that administrators play in the development of efficacy belief systems in science teachers.

FURTHER RESEARCH

A few teachers from groups that are high and groups that are low on the self-efficacy and outcome expectancy scales should be observed in their classrooms to determine differences in teacher behaviors as they relate to both scales. These teachers then should be interviewed to probe variations in personal background as they relate to science and chemistry teaching self-efficacy. Classroom visitations and interviews could establish a link between teacher efficacy belief systems in science or chemistry and teachers behaviors. Interviewing might possibly uncover variables not included in this study that could influence teachers' self-efficacy and outcome expectancy. Interviews may help to establish the importance of work experience for which there were too few cases to analyze statistically. Other unique experiences that relate to the development of science or chemistry teaching self-efficacy or outcome expectancy may be uncovered by these qualitative research techniques.

Studies should be made of the differences in educational background between teachers with elementary focus and teachers with secondary and /or middle school focus in order to ascertain the influence of these different backgrounds on the outcome expectancies of teachers.

Comparisons should be made between student achievement in science and student attitudes toward science that are obtained by teachers with high and low science and chemistry teaching self-efficacies and outcome expectancies. These comparisons could establish the effect of middle school teachers' efficacy belief systems on student learning and attitudes.

A study on a broader scale in both rural and urban schools should be carried out to probe the effects of science methods courses and workshops on self-efficacy in science and in specific content areas of science. Research on this larger and more varied population also could probe the effects of the external, student and family variables most necessary to science teaching self-efficacy and outcome expectancy.

Similar studies of middle school teachers' perceptions and efficacy belief systems need to be done in other science content areas, particularly physics at the middle school level, to discover teachers' perceptions and efficacy beliefs systems for the other content areas of middle school science. Studies of this type might point to other areas of emphasis for teacher education and inservice.

Additional analysis and development of the outcome expectancy scales in the STEBI and STEBI-CHEM may further delineate the constructs in these scales. Studies of these scales might point to other factors that affect teachers' perceptions of students learning.

SUMMATION

The findings and conclusions of this study need to be addressed by colleges, universities, school districts and those involved with teacher certification to assure that teachers involved with general science curriculum at the middle school level receive the support and education needed to raise their science and chemistry teaching self-efficacy and outcome expectancy. Such positive steps should be taken to ensure that middle school students receive the science and chemistry education they need to become contributing members of a highly technological society.

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Appendix 1

STEBI

****

Please indicate the degree to which you agree or disagree with each statement below by circling the appropriate letters to the right of each statement.

SA = STRONGLY AGREE
A = AGREE
UN = UNDECIDED
D = DISAGREE
SD = STRONGLY DISAGREE

1.	When a student does better in science, it is often because the teacher exerted a little extra effort.	SA A UN D SD
2.	I am continually finding better ways to teach science.	SA A UN D SD
3.	Even when I try very hard, I do not teach science as well as I do most subjects.	SA A UN D SD
4.	When the science grades of students improve, it is often due to their teacher having found a more effective teaching approach.	SA A UN D SD
5.	I know the steps necessary to teach science concepts effectively.	SA A UN D SD
6.	I am not very effective in monitoring science experiments.	SA A UN D SD
7.	If students are underachieving in science, it is most likely due to ineffective science teaching.	SA A UN D SD
8.	I generally teach science ineffectively.	SA A UN D SD
9.	The inadequacy of a students background can be overcome by good teaching.	SA A UN D SD
10.	The low science achievement of some students cannot be blamed on their teachers.	SA A UN D SD
11.	When a low-achieving child progessses in science, it is usually due to extra attention given by the teacher.	SA A UN D SD
12.	I understand science concepts well enough to be effective in teaching middle school science.	SA A UN D SD
13.	Increased effort in science teaching produces little change in some students' science achievement.	SA A UN D SD
14.	The teacher is generally responsible for the achievement of students in science	SA A UN D SD
15.	Students' achievement in science is directly related to their teachers' effectiveness in science teaching.	SA A UN D SD

16. If parents comment that their child is showing more interest in science at school, it is probably due to performance of the child's teacher. SA A UN D SD

17. I find it difficult to explain to students why science experiments work. SA A UN D SD

18. I am typically able to answer students' science questions. SA A UN D SD

19. I wonder if I have the necessary skills to teach science. SA A UN D SD

20. Effectiveness in science teaching has little influence on the achievement of students with low motivation. SA A UN D SD

21. Given the choice, I would not invite the principal to evaluate my science teaching. SA A UN D SD

22. When a student has difficulty understanding a science concept, I am usually at a loss as to him to help the student understand it better. SA A UN D SD

23. When teaching science, I usually welcome student questions. SA A UN D SD

24. I do not know what to do to turn students on to science. SA A UN D SD

25. Even teachers with good teaching abilities cannot help some kids to learn science. SA A UN D SD

Appendix 2

STEBI-CHEM

Please indicate the degree to which you agree or disagree with each statement below by circling the appropriate letters to the right of each statement.

SA = STRONGLY AGREE
A = AGREE
UN = UNDECIDED
D = DISAGREE
SD = STRONGLY DISAGREE

1.	When a student does better in the chemistry section of science it is often because the teacher exerted a little extra effort.	SA A UN D SD
2.	I am continually finding better ways to teach chemistry.	SA A UN D SD
3.	Even when I try very hard, I do not teach chemistry as well as I do most areas of science.	SA A UN D SD
4.	When students grades in the chemistry section of science improve it is often due to their teacher having found a more effective teaching approach.	SA A UN D SD
5.	I know the steps necessary to teach chemistry concepts effectively.	SA A UN D SD
6.	I am not very effective in monitoring chemistry experiments.	SA A UN D SD
7.	If students are underachieving in the chemistry section of science it is most likely due to ineffective chemistry teaching.	SA A UN D SD
8.	I generally teach the chemistry section of science ineffectively.	SA A UN D SD
9.	The inadequacy of a students background in chemistry can be overcome by good teaching.	SA A UN D SD
10.	The low science achievement of some students in the chemistry section of science cannot be blamed on their teachers.	SA A UN D SD
11.	When a low-achieving child progessses in the chemistry section of science it is usually due to extra attention given by the teacher.	SA A UN D SD
12.	I understand chemistry concepts well enough to be effective in teaching middle school chemistry.	SA A UN D SD
13.	Increased effort in chemistry teaching produces little change in some students' chemistry achievement.	SA A UN D SD

14.	The teacher is generally responsible for the achievement of students in the chemistry section of science.	SA	A	UN	D	SD
15.	Students' achievement in the chemistry section of science is directly related to their teachers' effectiveness in teaching.	SA	A	UN	D	SD
16.	If parents comment that their child is showing more interest in the chemistry section of science at school, it is probably due to performance of the child's teacher.	SA	A	UN	D	SD
17.	I find it difficult to explain to students why chemistry experiments work.	SA	A	UN	D	SD
18.	I am typically able to answer students' chemistry questions.	SA	A	UN	D	SD
19.	I wonder if I have the necessary skills to teach the chemistry section of science.	SA	A	UN	D	SD
20.	Effectiveness in chemistry teaching has little influence on the achievement of students with low motivation.	SA	A	UN	D	SD
21.	Given the choice, I would not invite the principal to evaluate my science teaching in chemistry.	SA	A	UN	D	SD
22.	When a student has difficulty understanding a chemistry concept, I am usually at a loss as to how to help the student understand it better.	SA	A	UN	D	SD
23.	When teaching chemistry, I usually welcome student questions.	SA	A	UN	D	SD
24.	I do not know what to do to turn students on to chemistry.	SA	A	UN	D	SD
25.	Even teachers with good teaching abilities cannot help some kids to learn chemistry.	SA	A	UN	D	SD

Appendix 3

SCIENCE BACKGROUND

Sex ____M ____F

What grade level(s) of science do you teach this year? ____________

How many sections of each level do you teach? ____________

Years of teaching experience prior to 1989-90 school year ______

Years of science teaching experience prior to the 1989-90 school year ____
(Science was the only or primary subject taught)

If you have been in a self contained elementary classroom teaching most all subjects please indicate the percentage of your time spent teaching science.
0-10 %___ 10-20%____ 20-30 %_____ 30-40%___ Other_____

Please indicate the amount of your total science teaching time that has been spent teaching chemistry topics.

None___	Very Little___	Some ___	Moderate___	Very Much__	Nearly All___
(0%)	(Less 20%)	(21-40%)	(41-60%)	(61-80%)	(More than 80%)

Have you had any chemistry related work experience other than teaching?____
If yes, please indicate the number of years.____ Please describe. ______

Have you had any other science or science related work experience other than teaching? ____yes ____no
If yes, please indicate the number of years.____ Please describe________

SCIENCE COURSEWORK

Please state whether you have taken any of the following courses by placing a 1, 2, 3 etc. to indicate the number of semesters and yes or no to indicate whether a laboratory experience was part of the course.

If you have taken science courses not mentioned please fill in the title of the course or a brief description.

HIGH SCHOOL COURSES (indicate # of semesters)		Laboratory (yes or no)	Year you graduated High School _______
General Science	____	____	
Biology	____	____	
Chemistry	____	____	
Physics	____	____	
Geology	____	____	
Advanced Biology	____	____	
Earth Science	____	____	
Other ________	____	____	
Other ________	____	____	

COLLEGE SCIENCE COURSES (indicate # of semesters)		Laboratory (Yes or No)
General Physical Science	____	____
General Biology	____	____
General Chemistry	____	____
Geology	____	____
Physics	____	____
Science Teaching Methods	____	____
Other ____________	____	____
Other ____________	____	____
Other ____________	____	____
Other ____________	____	____

PLEASE LIST ANY WORKSHOPS OR SUMMER INSTITUTES YOU HAVE TAKEN IN SCIENCE OR SCIENCE TEACHING SINCE RECEIVING A TEACHING CERTIFICATE AND INDICATE WHETHER THEIR PRIMARY FOCUS WAS SCIENCE CONTENT OR THE TEACHING OF SCIENCE. INDICATE THE TYPE OF SUBJECT MATTER INVOLVED (CHEMISTRY, PHYSICS, BIOLOGY ETC.) USE THE BACK IF NECESSARY

Workshop	Science Content	Teaching Science	Subject Matter
____________________	____	____	____
____________________	____	____	____
____________________	____	____	____
____________________	____	____	____
____________________	____	____	____

PLEASE INDICATE YOUR SUBJECT MATTER TEACHING PREFERENCE
FROM 1 (MOST FAVORITE) TO 6 (LEAST FAVORITE)

Language Arts - Math - PE - Social Studies - Science - Reading

____ ____ ____ ____ ____ ____

PLEASE INDICATE YOUR SCIENCE CONTENT TEACHING PREFERENCE
FROM 1 (MOST FAVORITE) TO 6 (LEAST FAVORITE)

Biology - Chemistry - Earth Science - Health - Physics - Technology

____ ____ ____ ____ ____ ____

Appendix 4

TEACHING QUESTIONNAIRE

Please circle, write or rank your answer to the following.

1. If you had your choice and found a teacher with which you could trade science content areas (you teach another content area to his/her students and s/he teaches chemistry to your students), would you trade?

a) definitely no   c) undecided   d) probably yes
b) probably no   e) definitely yes

2. I am comfortable with the use of the chemicals required to teach the chemistry portion of the curriculum.

a) strongly agree   c) uncertain   d) disagree
b) agree   e) strongly disagree

3. It requires more effort to teach chemistry than to teach other science content areas.

a) strongly agree   c) uncertain   d) disagree
b) agree   e) strongly disagree

4. The effort required to teach the chemistry section of the curriculum is well worth it.

a) strongly agree   c) uncertain   d) disagree
b) agree   e) strongly disagree

5. If you found a "really neat" experiment to explain a chemistry concept to your students, but it failed when your students tried it, what would you do for the following year?

____

____

6. Below are listed some external factors that could influence your ability to teach and thus affect your students' achievement. Please rank them from 1-5 as you perceive they influence your science teaching and your teaching of the chemistry section of your curriculum in particular. Add others if needed.
1 = Seriously Lacking; 2 = Moderately Lacking; 3 = No Effect;
4 = Moderately Favorable; 5 = Very Favorable

Factor	Science	Chemistry	Factor	Science	Chemistry
Facilities	____	____	Equipment	____	____
Supplies	____	____	School Rules	____	____
District Policies	____	____	Student Scheduling	____	____
District Science Coordination	____	____	School Science Coordination	____	____
Community Support	____	____	Textbook	____	____
Class Size	____	____	________	____	____
________	____	____	________	____	____

7. Below are listed some family variables that could influence student achievement. To what extent do you feel each of these affects your students' achievement in science and in the chemistry section of science.
1 = No Influence; 2 = Little Influence; 3 = Some Influence;
4 = Moderate Influence; 5 = Great influence.

Please add any other family variables you think are important.

Family Variable	Science Achievement	Chemistry Achievement
Home Environment	____	____
Family Values	____	____
Family Background	____	____
______________	____	____
______________	____	____

8. Below are listed some student variables that could influence student achievement. To what extent do you feel each of these affects your students' achievement in science and in the chemistry section of science.
1 = No Influence; 2 = Little Influence; 3 = Some Influence; 4 = Moderate Influence; 5 = Great influence .

Please add any other student variables you think are important.

Student Variable	Science Achievement	Chemistry Achievement
Science Background	____	____
Attention Span	____	____
Motivation	____	____
Past Academic Performance	____	____
Behavior	____	____
Self Discipline	____	____
______________	____	____
______________	____	____
______________	____	____

THANK YOU FOR YOUR TIME AND EFFORT !

PATH ANALYTICAL MODELS OF VARIABLES THAT INFLUENCE SCIENCE AND CHEMISTRY TEACHING SELF-EFFICACY AND OUTCOME EXPECTANCY IN MIDDLE SCHOOL SCIENCE TEACHERS

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ABSTRACT

Path analytical models based on a theoretical framework developed from the theories of Albert Bandura were constructed to determine factors that influence self-efficacy and outcome expectancy in both science and chemistry teaching for middle school science teachers. It was hypothesized that teaching chemistry in a general science curriculum at the middle school level was analogous to teaching science in the general elementary curriculum.

Factors initially hypothesized to influence science and chemistry teaching self-efficacies were coursework with laboratory experiences, science methods courses, teaching experience and other work experience not related to teaching. Outcome expectancies were hypothesized to be influenced by self-efficacy and a variety of variables that cluster into three groups, student variables, family variables and external variables.

Instruments measuring science and chemistry teaching self-efficacy and outcome expectancy were modified from instruments developed by Riggs (1988). Two questionnaires, based on current literature, were developed. One probed teacher backgrounds; the other explored teacher belief systems for student learning.

The participants were 105 middle school science teachers in a large urban midwestern school. Data was analyzed via structural equation modeling and t-tests.

Findings indicate a deviation from Bandura's theory in that teachers' self-efficacy was not a determinant of outcome expectancy, therefore, separate path models were analyzed for self-efficacy and outcome expectancy in both science and chemistry teaching. Chemistry teaching self-efficacy is different from science teaching self-efficacy for the middle school science teachers in this study. However, both are influenced by teachers' past experiences. Coursework with laboratory experience had a greater effect on the development of self-efficacy in these areas than did teaching experience, but the external variables of district level and community support also play a role. Teachers' expectations for student learning are based to some extent on external variables connected with the school but also on variables associated with students' families and each student as an individual.

Teachers with high chemistry teaching self-efficacy have characteristics important to effective chemistry teaching. Middle school science teachers perceive certain external variables to be more lacking for chemistry teaching than for science teaching.