SECONDARY SCIENCE TEACHERS' USE OF THE AFFECTIVE DOMAIN IN SCIENCE EDUCATION

by

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B.S., Kansas State University, 1978
B.S., Kansas State University, 1997
M.Ed., Wichita State University, 2003

AN ABSTRACT OF A DISSERTATION

submitted in partial fulfillment of the requirements for the degree

DOCTOR OF PHILOSOPHY

Department of Curriculum and Instruction
College of Education

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Manhattan, Kansas

2014

Abstract

The purpose of this qualitative case study was to explore (a) the types of student affective responses that secondary science teachers reported emerged in science classes, (b) how those teachers worked with student affective responses, and (c) what interactions were present in the classroom when they worked with student affective responses. The study was motivated by research indicating that student interest and motivation for learning science is low. Eight secondary science teachers participated in the case study. The participants were selected from a pool of teachers who graduated from the same teacher education program at a large Midwest university. The primary sources of data were individual semi-structured interviews with the participants. Krathwohl's Taxonomy of the Affective Domain served as the research framework for the study. Student affective behavior reported by participants was classified within the five levels of Krathwohl's Affective Taxonomy: receiving, responding, valuing, organization, and characterization. Participants in the study reported student behavior representing all levels of the Affective Taxonomy. The types of behavior most frequently reported by participants were identified with the receiving and responding levels of the Affective Taxonomy. Organization behavior emerged during the study of perceived controversial science topics such as evolution. Participants in the study used student affective behavior to provide feedback on their lesson activities and instructional practices. Classroom interactions identified as collaboration and conversation contributed to the development of responding behavior. The researcher identified a process of affective progression in which teachers encouraged and developed student affective behavior changes from receiving to responding levels of the Affective Taxonomy.

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Dedication

To Doug, my husband. Thank you for making this possible.

To Diana and Laura, my daughters. You are my inspiration. Thank you for cheering me on.

To Marguerite Joyce McGrew Bohnenblust, my first teacher.

Chapter 1 - Introduction

Overview of the Issues

In an era of educational accountability, many education policy makers view current student performance in the sciences to be unsatisfactory. Investigations show student interest in study of the sciences to be at a low level (Organisation for Economic Co-operation and Development, 2006). This is alarming since scientists and policy makers predict a high need for trained scientists and engineers in coming decades (National Science Board [NSB], 2006). While numerous resources have been invested into improving student achievement in science, test scores do not reflect the expenditure of resources, and student motivation to study the sciences is low (NSB, 2006; Osborne, Simon & Collins, 2003). As the pendulum of educational reform has swung toward cognitive evaluation and away from affective constructs such as attitude and self-motivation, educational research has focused on educational objectives within the cognitive domain (Bybee, 1995; Krathwohl, Bloom, & Masia, 1964/1984). However, researchers have called for a reexamination of the relationship between affect and student learning, particularly with regard to interest and motivation (Garritz, 2010; Noddings, 1996; Simpson, Koballa, Oliver, & Crawley, 1995).

Background of the Study

The affective, cognitive, and psychomotor domains comprise three areas of learning (Krathwohl, Bloom, & Masia, 1964/1984). While the affective domain includes emotions, feelings, values, and acceptance or rejection of a topic, the cognitive domain represents intellectual responses, and the psychomotor domain is a measure of the development of physical motor skills (Krathwohl et al., 1964/1984). Bloom's (1986) Taxonomy of the Cognitive Domain

has been used as a measure of effective teaching and successful learning. It was constructed as a continuum ordered on the principle of complexity with outcomes representing knowledge of topics and intellectual abilities. Bloom's Taxonomy contained cognitive learning levels of increasing complexity: knowledge, comprehension, application, analysis, synthesis, and evaluation (Bloom, 1986). Teaching strategies that developed learning at the analysis and synthesis levels of Bloom's Taxonomy were considered more successful in terms of outcomes than those that operated at the lower levels of the Taxonomy (Meyers, 1986).

Krathwohl's Taxonomy of the Affective Domain provided a classification system for developing affective educational objectives (Krathwohl, Bloom, & Masia, 1964/1984). As summarized in Table 1.1, it identifies levels of affect represented by behavioral responses associated with those levels. For this study the researcher chose to use the Taxonomy to identify student affective behavior within levels of the taxonomy. As an illustration, what does it mean to say that a student appreciates optics? Does it mean the student enjoys the study of optics? Alternatively, does it mean the student values the study of optics? Within the Affective Taxonomy, appreciation, enjoyment, and value are demonstrated by different behavioral responses and represent different levels of internalization of affect with appreciation and value corresponding to higher levels than enjoyment. A greater specificity is provided using the Affective Taxonomy to classify behavior, allowing a more accurate understanding of a student's affective response to a topic. Krathwohl's Taxonomy of the Affective domain, summarized in Table 1.1 is referred to as the Affective Taxonomy, Krathwohl's Taxonomy, or Krathwohl's Affective Taxonomy.

Table 1.1 Taxonomy of the Affective Domain: Responses and Examples

Category	Behavioral Response	Examples
Receiving	Being aware of or sensitive to the existence of ideas or topics and being willing to receive them.	Paying attention, compliance toward requirements, willingness to listen.
Responding	Actively responding to the ideas, materials, or topics of instruction.	Willingness to work on activities, self-starter, enjoyment, excitement, active involvement, satisfaction in topic and learning activities.
Valuing	Acceptance of the worth of a topic, showing advanced interest, high level of commitment to achieve, and expression of beliefs.	Seeking additional information, discussing it with others, working above and beyond requirements, drive and motivation to accomplish a task, expressing or advocating for a belief or value.
Organization	Conceptualization of values and organization of a value system. Creation of a hierarchy of values.	Comparison of personal values with new values, determining the position of new values with an internalized value system.
Characterization by a value or value complex	Acting consistently from an internalized, organized value system, and integration of values into a worldview.	Ability to consider issues and problems objectively, consistent code of behavior showing respect and kindness in actions toward others.

Note. *KRATHWOHL, DAVID R.; BLOOM, BENJAMIN S.; MASIA, BERTRAM B., TAXONOMY OF EDUCATIONAL OBJECTIVES BOOK 2/AFFECTIVE DOMAIN, 1st Edition, © 1984, pp. 37. 95. Reprinted by permission of Pearson Education, Inc., Upper Saddle River, NJ*

Krathwohl, Bloom, and Masia (1964/1984) suggested that there was no separation between the affective and cognitive domains of learning and that emphasis on one tended to

drive out the other. Other researchers suggested that affective learning must be present for any cognitive learning to occur (Claxton, 1991; Martin & Briggs, 1986; Smith & Ragan, 1999). Krathwohl et al. (1964/1984) called for research into the types of classroom activities and interactions that produced affective responses. Researchers suggested that a balanced approach to employment of instructional strategies to influence affect and cognition in education allowed for educational activities that addressed interest and value of a topic along with comprehension, application, and synthesis (Ringness, 1975; Bloom et al., 1981; Simonson & Maushak, 2001; Smith and Ragan, 1999).

In science education, researchers have investigated cognitive teaching and learning strategies developed to reach higher levels of cognitive educational objectives based on Bloom's (1986) Taxonomy. Notable among current methods that promote cognitive learning through discovery and inquiry is the 5-E Instructional Model (Bybee et al., 2006). This model allowed students to construct knowledge through a prescriptive process of engagement, exploration, explanation, elaboration, and evaluation. Within the five phases teachers addressed multiple learning styles, and directed students to explore a topic at multiple levels of understanding in numerous settings. A skilled teacher could develop lessons around this format that progressively led the student to higher cognitive levels within Bloom's (1986) Taxonomy of the cognitive domain. But affective educational objectives were not addressed in the 5E Model. This increasing attention to cognitive learning has come at a price. Research has shown that self-efficacy, motivation, and value in science learning can decrease as study progresses and becomes more complex (Zusho, Pintrich, & Coppola, 2003). In science education, the diversion of resources to achieve cognitive objectives appears to have come at the expense of recognizing the role of the affective domain in science education (Garritz, 2010).

While cognitive learning was addressed in science classes to develop conceptual understanding and problem solving ability, the affective domain often was intentionally avoided in science (Garritz, 2010). What were the reasons for lack of interest and attention to the affective domain in science? One explanation was the traditional image of science as reason driven and free of emotion (Alsop & Watts, 2003). Another reason was to avoid controversy and conflict with personal beliefs in topics such as evolution, geological time, and the origin of the universe (Scharmann, 1994). A third reason was that educators considered emotions unreliable (Noddings, 1996). Finally, educators suggested that student interest in a topic would be maintained through participation in inquiry activities, and that appreciation of the topic would develop with continued study (Bybee et al., 2006; Krathwohl, Bloom, & Masia, 1964/1984).

Science educators have called for research into the use of affect in improving science learning (Noddings, 1996; Simpson, Koballa, Oliver, & Crawley, 1995). The science curriculum was focused on the nature of science, including empiricism, predictability, experimentation, but a need existed for research into the emotions and feelings associated with studying perceived controversial science topics. While some research into the affective domain focused on attitudes and motivation in educational settings, additional research on the affective domain was needed in science education (Garritz, 2010; Simpson et al., 1995). Garritz (2010) suggested research into affect in science education could be used to develop pedagogical content knowledge constructs associated with affect (Shulman, 1986).

Statement of the Problem

The affective domain is an understudied area in science education. Many studies on student affect have focused on attitude and motivation (Garritz, 2010; Klopfer, 1976). However, as illustrated by Krathwohl's Affective Taxonomy (Table 1.1), the affective domain

encompasses multiple facets of human feelings, values, and associated behavioral responses (Krathwohl, Bloom, and Masia, 1964/1984). Many behavioral responses connected with the affective domain are experienced in science classes. For example, a student may express a love of biology due to the value attached to learning about animals, or a student may state that a theory of the origin of the universe conflicts with a personal religious belief. A student may experience a commitment to action in learning about the potential loss of an endangered species, while a study of the dangerous effects of radiation may cause a student to fear the use of radioactive isotopes in medicine. A need exists to understand the complex emotions associated with science topics and how they influence science learning.

Research Questions

The overarching question guiding the study is, What affective responses do secondary science teachers report, and how do they work with those responses as identified by Krathwohl's Taxonomy of the Affective Domain? Related to this overarching question are the following more specific research questions used to focus this investigation:

1. What types of student affective responses, as identified by Krathwohl's Affective Taxonomy, do science teachers report emerge in science classes?
2. How do science teachers work with student affective responses, as identified by Krathwohl's Affective Taxonomy, in teaching science?
3. What interactions do science teachers report are present in the classroom when they work with student affective responses as identified by Krathwohl's Affective Taxonomy?

Krathwohl's Taxonomy of the Affective Domain is a classification system of affective behaviors representing the types of "human reaction or response to the content, subject matter,

problems or areas of human experience" that reveal or call attention to "feeling, tone, an emotion, or a degree of acceptance or rejection" (Krathwohl, Bloom, & Masia, 1964/1984, pp. 3, 7).

Purpose of the Study

The purpose of this study is to examine the types of student affective responses that secondary science teachers report emerge in science classes, how those teachers work with student affective responses, and what interactions are present in the classroom when teachers work with student affective responses. The researcher first examined teachers' reports of types of affective responses from students in their science classrooms and identified those responses according to Krathwohl's Affective Taxonomy. Second, the researcher examined the reports of teachers to identify emergent themes associated with the types of affective responses that emerged, how science teachers worked with student affect, and the interactions that were present in the classroom when they worked with student affective responses.

Overview of the Theoretical Framework

The theoretical foundation of this study was the Taxonomy of the Affective Domain created by Krathwohl, Bloom, and Masia (1964/1984). The Taxonomy of the Affective Domain was designed as a continuum in which behavioral responses were classified according to increasing degrees of internalization of affect (Krathwohl et al., 1964/1984). Internalization represented the concept that affect existed at different levels due to inner growth, resulting in changing values, attitudes, and interests. At the lowest level of internalization, a student was aware and listened to a topic. At middle levels of internalization, the student showed interest, enjoyment, and value in learning. At the highest level, the student developed and acted according to a fixed value system. Student development within the affective domain was considered to be

an educational achievement in its own right rather than a means to cognitive learning. and interests.

The Affective Taxonomy was intended to provide a framework for development of affective educational objectives. However, the researcher believes that teachers need to have a thorough understanding of student affective behavior before creating affective objectives. Therefore, for this study the researcher chose to use the Affective Taxonomy to identify student affective behavior as reported by teachers within levels of the Affective Taxonomy. In examining science education through this theoretical lens, the researcher examined and interpreted teachers' reports of student behavioral responses in terms of the levels of Krathwohl's Affective Taxonomy and the activities or topics that produced those responses.

Methodology

This study explored the types of student affective responses that teachers reported emerged in science classes, how teachers worked with student affect, and what interactions were present in the classroom when teachers worked with student affective responses. This study was designed using qualitative methodology because of the need to understand a complex topic and because of the descriptive nature of the topic (Creswell, 2013b). In order to understand the types of affective responses teachers reported and how teachers worked with student affect, it was necessary to hear their descriptions. Case study was used to present a detailed description of teachers' reports of affect in the classroom (Glatthorn & Joyner, 2005). The study was sociological in nature because it investigated the interaction between students and teachers (Glatthorn & Joyner, 2005). The researcher selected participants from a pool of secondary science teachers with similar teacher education background. The bounded system of this case study was science teachers who graduated from the secondary science teacher education program

at Kansas State University from 2006 to 2011. Selection of participants from this pool allowed the researcher to examine the issue of affect in science learning with teachers who shared the same experience in learning about affect in classes that were a part of their formal teacher education. In their science teacher education program, teachers in the selection pool took Science Methods for Secondary and Middle Schools and Laboratory Techniques in the Teaching of Science. In these classes, science teachers learned to allow their students to express their attitudes, emotions, and beliefs during the study of science topics. Participants selected from the pool were practicing science teachers representing a variety of content areas and selected for the descriptive value and amount of information available in their responses to an initial selection questionnaire (Stake, 1995). The researcher conducted semi-structured interviews with the participants, made classroom observations, created field notes and debriefing notes, and examined student work samples to explore participants' reports of the types of student affective responses they observed, how they worked with student affect, and the interactions that occurred when they worked with student affect (Marshall & Rossman, 2006).

Significance of the Study

The National Science Board (2006) reported there is a need to improve U.S. science and mathematics education. According to the Organisation for Economic Co-operation and Development [OECD] (2006), among 29 nations participating in a study of fifteen-year-old students' use of math and science knowledge, U.S. students ranked near the bottom. The OECD (2006) report also indicated a low level of student interest in science education. Student choices about studies and career paths were influenced by educational experiences. Research into improving the quality of science education has focused on improvements in educational objectives within the cognitive domain. Yet, some educators propose that more research is

needed in the affective domain in relation to science education (Garritz, 2010; Noddings, 1996; Simpson, Koballa, Oliver, & Crawley, 1995). This study was intended to provide insight into the affective domain by examining secondary science teachers' reports of the types of student affective responses they observed, how they worked with student affect, and the interactions that occurred when they worked with student affect. The study focused on teachers' reports of affective responses from students and the context in which they occurred. Potential new knowledge may be provided in the area of pedagogical content knowledge by revealing content, pedagogy, and contextual knowledge related to the affective domain (Garritz, 2010; Shulman, 1986). The results of this study will benefit researchers and practitioners in science education.

Limitations and Delimitations of the Study

A limitation of the study was that the interviews were conducted individually and in-person. In the face-to-face interview, participants may not feel free to disclose or may want to say what they feel is expected. The number of teachers who could be contacted was also a limitation of the study. The researcher was limited by the use of volunteers, as their perspective may have been very different than those who declined or were not used based on their responses to an initial questionnaire. A delimitation of the study was the selection of teachers and the size of the pool of teachers from which the participants were selected. The participants were selected from a pool of practicing secondary science teachers who completed the secondary science teacher education program at Kansas State University between 2006 and 2011.

The researcher recognizes that this bounded system limits the transferability of the study. However, she believes the findings of the study provide key elements of secondary science teachers recognizing, developing, and working with student affect in the secondary science classroom. The findings of the study may transfer to science teachers who have similar

experiences with students. The intent of the researcher is that these findings may provide information useful to science teachers, educators, and researchers and may influence student interest and success in the study of science.

Bias

Interpretation of the findings should be viewed with an understanding of the researcher's knowledge of the participants and her professional background. The researcher taught some of the participants in the study in their science methods and laboratory techniques classes. In addition, the researcher was the university supervisor for some of the participants during their student teaching experience. As a former secondary science teacher and science methods instructor, the researcher's observations and perceptions were filtered through the lens of her own experience. While the researcher brought her own preconceptions to the project, she implemented the study with the intent of remaining objective in posing questions and collecting and analyzing data.

Definition of Terms

Affective Domain of Learning: The types of behavioral reactions and responses representing "feeling tone, an emotion, or a degree of acceptance or rejection" that students develop in response to instructional topics and activities (Krathwohl, Bloom, & Masia, 1964/1984, p. 7).

Affective Progression: For the purposes of this study, the researcher defined affective progression as behavior changes in response to instructional activities, indicating changing levels of affect. Affective progression is indicated by observations of behavior.

Behavioral Construct: A complex psychological concept representing a combination of behaviors. Behavioral constructs are measured using self-reporting surveys and Likert scales (Kearney & Beatty, 1994).

Behavioral Response: An action or verbal expression resulting from a circumstance or interaction. Examples of behavioral responses are smiling, frowning, and laughter. (Krathwohl, Bloom, & Masia, 1964/1984).

Cognitive Domain of Learning: The area of learning representing knowledge and the development of intellectual abilities (Krathwohl, Bloom, & Masia, 1964/1984).

Conceptual Change: Learning that changes or replaces an existing belief, idea, or way of thinking with another belief, idea, or way of thinking. The new way of thinking becomes the conceptual framework used to understand and process phenomena (Hewson & Lemberger, 1999).

Emotional Scaffolding: Using knowledge and understanding of student emotions to overcome frustration and facilitate learning progression (Rosiek, 2003).

Internalization: The concept that affect exists at different levels due to inner growth, resulting in changing values, attitudes, and interests (Krathwohl, Bloom, & Masia, 1964/1984).

Pedagogical Content Knowledge: The content knowledge, effective pedagogy, and contextual understanding required for teaching in a content area (Shulman, 1986).

Operational Management: Providing appropriate instruction at the appropriate levels and times needed to build interest, motivation, and understanding of a topic (Stronge, 2007).

Summary

The need for educational reform to improve science learning has produced research into strategies designed to improve students' abilities to learn science knowledge. Most of this research has focused on educational methods directed toward the cognitive domain of learning. Researchers have suggested that an understanding of student affective responses to science topics can be used to improve science learning. A gap exists in the research in this area with regard to

how teachers work with the affective domain and how students interact and respond to teaching strategies that draw out and develop affective responses. This study was designed to provide new information about teachers' use of the affective domain in science education. The overarching question guiding the study was, What affective responses do secondary science teachers report, and how do they work with those responses as identified by Krathwohl's Taxonomy of the Affective Domain? Secondary science teachers were interviewed to gain information about the types of affective responses they observed in their students, how they worked with those responses, and the interactions that occurred when they worked with those responses. Teachers' reports were analyzed for patterns and trends to identify emergent themes.

Chapter 2 - Literature Review

Educational researchers have considered the affective domain to be an integral part of the learning experience. Bloom, Madaus, and Hastings (1981) considered affect and cognition to be inseparable and overlapping in the learning process. Aspects of cognitive learning corresponded to affective counterparts and vice versa (Bloom et al., 1981). According to Bloom (1976), affective characteristics guided responses to content and issues, and the desired learning outcomes were accompanied by corresponding affective outcomes. Ringness (1975) suggested that a balance between affect and cognition was needed in the educational setting, claiming that too much attention to affect reduced cognitive achievement while exclusive focus on cognitive achievement created a sterile affective environment. Smith and Tyler (1942) stated that attitudes and interests were the driving forces of educational success, determining what students could learn efficiently and effectively. Anderson and Bourke (2000) considered affect the means to the cognitive end in education, citing engagement and interest as the antidote to disinterest accompanied by disruption. Researchers called for the evaluation of affect in the educational setting (Bloom et al.). Failure to evaluate affect led to neglect of the affective domain and "exclusive emphasis on cognition" (Bloom et al., p. 300). Bloom et al. considered evaluation of student affect as a way to assess the efficacy of teachers' instructional practices.

Behavioral Theories of Cognition and Affect

Separation of cognition and affect was a theoretical concept accepted by historical philosophers (Alsop, 2005; Gephart, Ingle, & Marshall, 1976). Descartes claimed the mind and body were separate entities, and associated knowledge with the mind and emotions with the body (Alsop, 2005). Socrates believed emotions obstructed learning and understanding. Rationality

was considered more valuable, and emotions were denied in favor of reason. Educational researchers and psychologists rejected the separation of emotion and reason, claiming that interests and attitudes were connected to the understanding of information. (Smith & Tyler, 1942). Bandura's (1986) Social Cognitive Theory claimed that behavior, affect, cognition, and environmental factors influenced human ability to construct reality, self-regulate, and encode information. Central to Social Cognitive Theory was the concept of self-efficacy, confidence in one's ability to accomplish a task, which explained the combined influence of affect and cognition on the ability to accomplish a task. Fishbein's Expectancy Value Theory explained that behavioral choices were based on the interaction between a person's beliefs and values (Fishbein & Ajzen, 1975). Individuals used their beliefs to establish the value of a topic and chose behavior based on the most favorable outcome. Educational researchers claimed that affect and cognition were both necessary and intertwined in the educational process, and that separation of the two was an impractical and inefficient educational practice (Bloom, 1976; Tyler, 1973). According to researchers, cognitive and affective behaviors were interrelated and, could not be separated (Anderson & Bourke, 2000; Bloom, Madaus, & Hastings, 1981; Claxton, 1991; Martin & Briggs, 1986). Interest, attitudes, and values, while considered to be affective constructs, required developed cognitive knowledge and understanding (Anderson & Bourke, 2000; Bandura, 1986; Smith & Ragan, 1999; Smith & Tyler, 1942). Judgment and evaluation on the value of a topic were cognitive responses that led to a decision on the (a) worth of a topic, (b) the attitude and interest toward, and ultimately (c) the value associated with that topic (Aiken, 1980; Bandura, 1986; Gable & Wolf, 1993).

Affect and Educational Goals

In the Eight Year Study of American Education, Smith and Tyler (1942) periodically evaluated students from thirty experimental and traditional schools as they progressed from high school to college to determine if innovative education approaches influenced student outcomes. Their study examined student performance on standardized tests and student affective responses to educational topics. Evaluators used observations, records, surveys, and interviews to determine affective development. In addition to measuring student performance, the study identified and defined affective characteristics common to students in educational settings. Smith and Tyler (1942) believed that the purpose of education was to establish and support the common welfare of society. In that role, the affective domain in education could not be ignored. Smith and Tyler (1942) further advocated that educators should determine affective characteristics that benefitted society and develop them through regular instruction and assessment. They considered affect to influence the personal development of the student.

Avoidance of the Affective Domain in Education

While cognition is considered an essential part of education and learning, use of the affective domain in education has been controversial (Anderson & Bourke, 2000; Bloom, 1976; Bloom, Madaus, & Hastings, 1981; Gephart, Ingle, & Marshall, 1976). Educators tended to avoid the affective domain, citing issues of privacy, assessment, and rigor. A student could be assessed on facts of a topic, but the value or appreciation of the topic was considered a personal and private concern. Educators, parents, and policy makers considered values to be exclusively the domain of the home and church, arguing that educators should be concerned with behavior in the classroom, but the values that influenced that behavior should be taught in the home or religious institutions (Krathwohl, Bloom, & Masia, 1964/1984; Tyler, 1973). Further, instruction

in affective characteristics was considered by critics to be a type of educational indoctrination (Bloom, Madaus, & Hastings, 1981). Some educators did not consider emotions, feelings, and values to be a part of a rigorous education (Bloom, 1976; Tyler, 1973). These areas were considered social and leisure in nature and, therefore, not worthy of educational instruction. In addition, these characteristics were considered to develop as a part of normal growth, independent from instruction. Therefore, no need existed for using instructional time on their development (Tyler, 1973). Affective characteristics were considered difficult to assess and variable from student to student. Students' affective responses may have resulted from a desire to please rather than a true outgrowth of education (Bloom, 1976).

Regardless of the desire or obligation to separate affect from learning, students brought affective traits to school and left with them when they exited (Anderson & Bourke, 2000, Bloom, 1976). Anderson and Bourke (2000) claimed that affect was a part of the lens through which students viewed their educational experience, and as such, influenced their performance in school. Those students demonstrating more positive attitudes toward school were higher achievers than those showing negative attitudes.

Characterization of Affect

Affective constructs identified by behavioral psychologists included attitude, opinion, interest, value, belief, and need (Gephart, Ingle, & Marshall, 1976). In developing the Affective Taxonomy, Krathwohl, Bloom, and Masia (1964/1984) considered affective constructs to be common characteristics. Common affective characteristics identified by Krathwohl et al. (1964/1984) included attitude, interest, appreciation, value, and adjustment. Krathwohl et al. considered these constructs too broad in meaning to be used in the Affective, but identified their connections to levels of the Taxonomy (Table 2.1). Smith and Tyler (1942) considered affective

constructs such as appreciation, interest, and attitude to be learned and measurable. Piaget (1965) and Kohlberg and Turiel (1971) found that adolescence was a time of changing moral development. In the following sections the researcher discusses common affective constructs.

Attitude

Allport and Allport (1921) identified attitude as a distinct personality trait. In their study of personality traits, they performed correlations of personality observations and descriptions provided by college student participants. Gordon Allport (as cited in Gable & Wolf, 1993) stated that attitude represented a "mental and neural state of readiness" (p. 5). In his research on personality factors, Cattell (1945) used observations, questionnaires, and objective tests to collect data on affective responses. Using factor analysis, Cattell determined that attitude was a driving motivational force. He considered attitude to be "readiness to act" (as cited in Aiken, 1980, p. 3). In their expectancy value theory, Fishbein and Ajzen (1975) characterized attitude as a person's predisposition to respond in a consistent manner to a person, object, situation, or concept. Attitudes were a result of the interaction of cognitive knowledge and judgments based on knowledge or values (Fishbein & Ajzen, 1975).

Interest

Cattell (1945) considered interest a component of attitude in that interest contributed to attitude toward an object or person. Aiken (1980) differentiated interest from attitude in that interest represented a response without judgment whereas attitude developed from judgment. Izard (1991) identified interest as an emotion that caused focus of attention on an object or topic. Interest was the most common positive emotion experienced by normal human beings. In a study of human emotional responses, Izard (1979) videotaped human expressions and identified distinctive universal human facial expressions and physiological activity indicating interest.

Bartlett and Izard (1972) directed participants to imagine or reflect upon a time or event in which they experienced interest. Dimensional analysis of their responses identified specific feelings associated with interest, including excitement, engagement, curiosity, and enlivenment. According to Izard (1991), enlivenment associated with interest allowed the learner to accomplish complex cognitive activities.

Appreciation

Smith and Tyler (1942) evaluated appreciation demonstrated by high school students as a part of their Eight Year Study. They periodically interviewed students in thirty secondary schools as they progressed from high school to college to determine if innovative education approaches influenced student outcomes. In addition to measuring student performance, the study examined teacher objectives and intended outcomes. Smith and Tyler (1942) noted that many educators in the study included appreciation of a topic in their desired outcomes for students. From research on student responses, they determined that appreciation was related to an "understanding of deeper meanings of a topic or activity" (Smith & Tyler, 1942, p. 313). Appreciation and interest both were associated with liking an activity, but appreciation included "insight into the activity: understanding it, realizing its true value" (Smith & Tyler, 1942, p. 313).

Value

Value included two dimensions, the worth of an object and belief that guided action. Aiken (1980) described value as "the importance or worth attached to particular activities and objects" (p. 2). In a study of 190 college freshman men and women, Aiken (1974) analyzed responses to questionnaires on attitudes toward mathematics. Based on this study, Aiken (1974) concluded that value should be considered a distinct affective construct. Rokeach (1973) characterized values as standards or beliefs that guided conduct or action. Values were the

individual's guiding influence for specific interests, attitudes, and appreciation. Maslow (1959, 1964) studied value through interviews and observations of various groups and through examination of historical records and biographies. He associated value with the desirability or satisfaction associated with achievement.

Adjustment

Adjustment was considered the most complex of the affective constructs (Smith & Tyler, 1942). In their observations and interviews with students from the thirty schools of the Eight Year Study, they determined that adjustment represented maturation and adaptation to the physical and social environment. Feelings of adequacy, personal happiness, and attention to inner conflict were all associated with adjustment. Adjustment was viewed as a process of growth rather than individual impulses.

Moral Development

Piaget (1965) found two stages in moral development, the first existing in preadolescent children and the second in post-adolescent children. In children younger than ten, rules were considered absolute and unchangeable, and moral judgments were based on consequences. During adolescence, individuals learned that rules could change depending on circumstances. The post-adolescent understood rules as a way to get along in society, and moral judgments were based on intentions (Piaget, 1965). Kohlberg and Turiel (1971) identified six stages of moral development. In the first stage, children viewed rules as absolute. In stage two, children recognized that rules could change with the circumstances. In stage three, appearing in preadolescence, morals represented good behavior while in stage four, developing during adolescence, morals were seen as the rules of society. In stages five and six the individual began to see moral judgment in terms of basic rights and justice. In both theories, adolescence was a

time of changing moral development. In Kohlberg and Turiel's (1971) theory, the process of developmental change continued into adulthood.

Development of the Affective Taxonomy

Similarities and interrelationships of affective constructs such as interest, attitude, and value resulted in multiple interpretations of their associated meanings (Bloom, 1976; Krathwohl, Bloom, & Masia, 1964/1984). For example, human responses associated with appreciation ranged from a general interest to a strong commitment. Because of the frequent usage and variety of meanings, Krathwohl et al. (1964/1984) did not consider these terms useful in describing student affect in the Affective Taxonomy. A recognized set of defined terms representing affect was needed to create a framework for research into affective responses. While educational psychologists were united in their desire to evaluate human behavior in the academic setting, there was no common method or approach to developing instruments for educational evaluation (Krathwohl et al.). Smith and Tyler (1942) found that most schools limited evaluation of students to knowledge of facts and proficiency in skills with no evaluation of behavioral outcomes. Bloom, Krathwohl, and others recognized a need for a common set of educational outcomes in American schools (Bloom, 1976, 1986; Krathwohl et al., 1964/1984). They determined that most instructional activities targeted learning in three domains: cognitive, affective, and psychomotor. The Taxonomy of Educational Objectives, Handbook I: Cognitive Domain (Bloom) was originally published in 1956 followed by Handbook II: Affective Domain (Krathwohl et al.) in 1964. The purpose of the Affective Taxonomy was to provide an accepted terminology defining student affective responses for the creation of affective educational objectives.

Internalization

In developing the Taxonomy, Krathwohl, Bloom, and Masia (1964/1984) recognized that affective behavior changed over time and that behaviors represented different levels of affect. They referred to the process of changing affect as internalization and described levels within the internalization process through which an individual progressed. At the lowest level of internalization of a topic, designated level 1, a student exhibited Receiving behavior. Progressively higher levels of internalization included level 2 Responding, level 3 Valuing, level 4 Organization, and finally, level 5 Characterization. These levels became the hierarchical structure of the Affective Taxonomy as shown in Table 2.1.

Affective Constructs

Affective constructs labeled attitude, interest, appreciation, value, and adjustment were considered common affective terms and represented wide ranges of meaning (Krathwohl, Bloom, & Masia, 1964/1984). These common terms were associated with more than one category in the Affective Taxonomy. Their locations within the Affective Taxonomy were based on the internalization level of those constructs. Table 2.1 shows the relationship between common affective terms and the categories within the Affective Taxonomy continuum.

Table 2.1 The Range of Meaning Typical of Commonly Used Affective Terms Measured Against the *Taxonomy* Continuum.

1.0 Receiving	1.1 Awareness					Interest
	1.2 Willingness to Receive					
	1.3 Controlled or selected attention				Appreciation	
2.0 Responding	2.1 Acquiescence in responding					
	2.2 Willingness to respond	Adjustment	Values	Attitudes		
	2.3 Satisfaction in response					
3.0 Valuing	3.1 Acceptance of a value					
	3.2 Preference for a value					
	3.3 Commitment					
4.0 Organization	4.1 Conceptualization of a value					
	Organization of a value system					
5.0 Characterization by a value or value complex	5.1 Generalized set					
	5.2 Characterization					

Note. *KRATHWOHL, DAVID R.; BLOOM, BENJAMIN S.; MASIA, BERTRAM B., TAXONOMY OF EDUCATIONAL OBJECTIVES BOOK 2/AFFECTIVE DOMAIN, 1st Edition, © 1984, pp. 37. 95. Reprinted by permission of Pearson Education, Inc., Upper Saddle River, NJ*

Affect in Educational Research

Studies on affect in education have focused on recognizing and measuring affective responses related to instructional activities and learning. Summaries of research studies of education and the affective domain are included here. Table 2.2 summarizes the studies, methods, and findings.

Affect and Learning

In a study of affective learning, Chory and McCroskey (1999) measured factors that influenced positive attitudes toward learning. One hundred eight college students enrolled in communications classes participated in the study. Students completed three self-reporting instruments evaluating their teacher and their own learning: Teacher Management Communication Style, Affective Learning Scale, and Non-verbal Immediacy. Chory and McCroskey (1999) determined that two factors influenced positive attitudes toward learning: students' feelings of trust in their teachers and interactive communication between teachers and students. The researchers determined that in classes where students reported feelings of trust in their teachers and where interactive communication occurred between students and teachers, students reported more positive interest in the topic of study.

In examining the relationship between affect and learning, Isen, Daubman, and Nowicki (1987) demonstrated that creative thinking performance was higher in participants after inducing positive affect than in those in which no positive affect was induced. Isen (1993, 1999) defined positive and negative affect as positive or negative feelings created through an outside stimulus. According to Isen et al. (1987), positive affect or feelings could be stimulated in people through simple means. Small, unexpected gifts or watching comedy films created positive feelings in their subjects. Films about sad or harmful topics produced negative feelings in participants. Isen

et al. created a study testing the relationship between creativity and induced positive affect. Sixty-five college students enrolled in Introductory Psychology participated in the study. Participants were asked to perform the Dunker candle test (as cited in Isen et al.). Given a set of materials, participants were asked to attach a candle to a corkboard wall in such a way that the candle did not drip wax when burned. One group was exposed to positive affect in the form of watching a comedy film before the test while a second group watched a neutral affect film. Chi-squared tests showed that positive affect participants produced significantly more solutions than the neutral affect participants did. The positive affect group showed improved ability in word association, classification, and problem solving tasks. Ashby, Isen, and Turken (1999) theorized that the relationship between positive affect and improved cognitive performance was due to increased levels of dopamine in the frontal cortical areas of the brain.

In a study of 190 college freshman men and women, Aiken (1974) surveyed the students with two instruments designed to evaluate enjoyment and value of mathematics, along with scholastic and background information. The instruments used a Likert scale for responses indicating levels of favorable attitude toward mathematics. Analyses of responses to the two instruments indicated that enjoyment correlated to mathematic ability and interest, while value was associated with high verbal and scholastic ability.

Nieswandt (2007) investigated the relationship between affective variables and conceptual understanding in ninth grade chemistry classes. In the study, Nieswandt created surveys and tests to measure participants' interest in the subject of chemistry, self-concept, attitude toward chemistry, and conceptual understanding. The surveys and tests were administered in the first and second semesters of grade nine and at the beginning of grade ten. Data on affective variables were collected using self-reporting measures in a five point Likert

scale. Conceptual understanding was tested using chemistry problems. These data were analyzed using structural equation modeling. In the analysis, self-concept was shown to become stable from the first semester to the second and in combination with situational interest showed a positive influence on self-concept and a positive effect on conceptual understanding. The findings indicated students' interest in chemistry generated positive self-concept, which ultimately developed meaningful conceptual understanding.

In another study of chemistry students, Zusho, Pintrich, and Coppola (2003) investigated changes in affective and cognitive behavior over time in order to learn about the effect of long, challenging studies on student attitude, motivation, and learning activities. Four hundred fifty-eight college students enrolled in Chemistry I participated in the study. In this study, students reported motivation, self-efficacy, task value, interest, anxiety, and cognitive strategies over the course of the class. Levels of interest were measured using an interest scale based on Elliot and Church's intrinsic motivation scale (as cited in Zusho, Pintrich, & Coppola, 2003). Self-efficacy, task value, motivation, and anxiety were measured using questions from the Patterns of Adaptive Learning Survey (PALS) and Motivated Strategies for Learning Questionnaire (MSLQ), and cognitive activities were measured using questions from the MSLQ. The results of the study indicated that as the cognitive load on students increased over time, self-efficacy, motivation, and task value decreased and interest and anxiety remained the same.

Perrier and Nsengiyumva (2003) studied children orphaned in the 1993 Rwandan genocide. The researchers proposed that constructivist science activities could be used as therapy for traumatized children. Data were collected in the form of notes during preparation before the activity, observations during the activities, and notes during debriefing sessions after the activity. Observations included bored face, not listening, asking questions, touching, making suggestions,

hanging around after the session, laughing, making noises, talking with neighbors, and working alone. The children were given activities in which they worked with tools, explored a topic, and made predictions. Science was presented as a way of understanding the world rather than a topic of study. Most of the children had emotional scars from the violence and many were considered in psychological shock. Initially, the children were quiet and exhibited little interest in the activity. However, when presented with a "magic box" to be examined and explained, they became actively involved in the activity (Perrier & Nsengiyumva, 2003, p. 1116). During activities, progressive questioning was used to elicit responses from the children. Tasks that the children were asked to perform included constructing polyhedrons from sticks, explaining properties of liquids, and examination of insects followed by correctly drawing the insects. The children were able to perform the science activities successfully and exhibited previously absent emotional responses to each other and the authors. The study demonstrated that constructivist science activities could lead to the development of affective responses in children. Perrier and Nsengiyumva (1993) concluded, "The affective dimension is not just a simple catalyst, but a necessary condition for the learning to occur" (p. 1124).

Affect and Conceptual Change

Schwitzgebel (as cited in Hewson & Lemberger, 1999) theorized that people have an explanation-seeking quality that is associated with affect and arousal when encountering a phenomenon that cannot be explained by their existing internalized concepts. In investigating this idea, Hewson and Lemberger (1999) presented a study designed to confirm that conceptual change is accompanied by emotional response. In a high school genetics class students used a computer based genetics lab to progress in conceptual understanding from Mendel's simple dominance model to models of codominance, multiple alleles, X-linkage, and autosomal linkage.

Data on the students' responses to the classroom activity were collected in the form of audio recordings. The recordings were transcribed and analyzed for responses representing agitation and arousal. Students used problem-solving methods to create new explanations for anomalies that did not fit with the simple dominance model. As students worked through a process of developing models of inheritance, testing their models, and replacing them with new ones, conceptual change occurred. This change was accompanied frequently by affective responses indicating excitement, satisfaction, and pride in their work. The learning activities required a process of continuous conceptual change. Behavior patterns of affect and arousal were seen in the students when they successfully developed theories to explain anomalies in the activity of alleles during inheritance.

Scharmann, Smith, James, and Jensen (2005) examined student conceptual change in learning about evolution and the nature of science. Conceptual change was considered evident when students identified intelligent design as less scientific than evolution or umbrellaology. The authors developed a method to facilitate conceptual change in student beliefs about intelligent design as a scientific theory. Nineteen science education students participated in the qualitative study. Data were collected in the form of reaction papers to assigned readings, comments from students during class discussions, nature of science evaluation, and final written reflection essays. In the study, students examined evolution in the context of the nature of science as well as comparing it with personal views of the origin of species. Students were encouraged to discuss and develop their own ideas with their peers. Religious beliefs and values related to evolution were acknowledged early in the study. The instructor acted as facilitator, encouraging discussion and mutual respect for each other's views, religious beliefs, and values. The instructor also provided supporting information for the discussion. After readings and discussions about the

nature of science, the theory of evolution, intelligent design, and a pseudo-science study, *Umbrellaology* (Somerville, 1941), students were encouraged to respond in a written exercise by placing evolution, intelligent design, and umbrellaology on a continuum from less scientific to more scientific. Scharmann et al. (2005) suggested that addressing religious beliefs early in the study influenced conceptual change.

Emotional Scaffolding

In a study of the affective domain, pedagogical practices, and learning, Rosiek (2003) examined the concept of emotional scaffolding. Emotional scaffolding represented teachers using their knowledge and understanding, of student emotions to help their learning progression. Data were collected from focus groups in the form of examples of pedagogical practices used by teachers to assist student learning. Focus group discussions were examined and cataloged by subject matter, intended effect, and scaffolding type. Focus groups reviewed other groups' discussions and contributed additional examples for designated categories. Findings indicated that emotional scaffolding was a frequent pedagogical practice designed to elicit and use students' emotional response to a topic. Data about this practice were organized into multiple case studies and narratives demonstrating examples of emotional scaffolding used to enhance learning. In one case, a teacher recognized that students were experiencing frustration and unease with a science activity requiring that they identify an unknown (Rosiek, 2003). The teacher used the analogy of driving the lane in basketball to help the students move beyond frustration. In the example, a player didn't know which way the opponent would go, so he made a move to try to get the opponent to move in one direction. Similarly in a science lab, the student must try one test to see which direction to go in the study progression. In this example, the teacher used

knowledge of students' values of one topic and transferred that value to the classroom topic. The teacher created a bridge from a frustration response to a valuing response.

Scharmann, Smith, James, and Jensen (2005) used reflection in lessons on evolution and the nature of science. These reflection assignments created emotional scaffolding in students during the study of evolution. Many of the secondary science education students in the study described themselves as Christian or conservative Christian. The study of evolution was resisted by students who viewed it as a challenge to their faith. Scharmann et al. (2005) suggested that allowing students to place evolution and intelligent design in a continuum from less scientific to more scientific was less confrontational than asking them to accept or reject either topic. The activity provided emotional scaffolding by encouraging students with negative attitudes toward the theory of evolution to move beyond rejection of the topic to an understanding of the value of the theory. The researchers in the study created a classroom environment of respect for religious beliefs and values while encouraging study and discussion of the theory of evolution. The activity allowed students to find a "place to stand" rather than requiring that they completely accept or reject evolution (Scharmann et al., p. 38). The researchers concluded that a classroom environment of respect for religious beliefs and a thorough understanding of the nature of science facilitated successful understanding and valuing of the theory of evolution.

Identifying Levels of the Affective Taxonomy

Of the studies represented in this review, only McNerney, Soled, and Kukreti (2006) referred to levels within Krathwohl's Taxonomy. In their study, seventh through twelfth grade science teachers participated in a professional development workshop about engineering. Data were collected from focus groups, journals, and surveys and were catalogued in terms of satisfaction, self-efficacy, and attitude. Within those constructs, researchers identified levels of

the Affective Taxonomy demonstrated by teachers throughout the study based on types of behavioral responses. During the workshop, teachers participated in open-ended inquiry and design processes used in engineering. The results showed that the teachers expressed responses representing levels one through four of Krathwohl's Affective Taxonomy. At level one, the teachers were receptive to the activities while expressing doubts about their abilities and the value of the program. At level two, the teachers recognized the need to participate while expressing some frustrations. At level three, the teachers demonstrated confidence and an understanding of the value of the program. At level four, the teachers were committed to the program and considered how to bring the material into their classrooms. The progression through levels of the Affective Taxonomy was not linear. The teachers tended to return to lower levels and then progress back to higher levels throughout the program.

Other studies in this review did not classify affective responses in terms of Krathwohl's Taxonomy, but it was possible to identify categories of affect corresponding to Krathwohl's Taxonomy from the description of behavioral responses in those studies. In their study of Rwandan orphans, Perrier and Nsengiyumva (2003) proposed using constructivist science activities as therapy for Rwandan orphans. While not specifically referring to Krathwohl's Taxonomy, the authors described activities in which the children responded with different levels of emotion. In one activity, children were asked questions to measure their knowledge of anatomy and behavior of living organisms. In addition to identifying the cognitive level of the questions, each question was assigned an emotional response level based on the researchers' reports of students' responses. A question about the number of legs on a spider produced a low emotional response, while a question about a mosquito sucking blood produced a medium emotional response. A question about the increase in heart rate in response to fear produced the

highest emotional response. The authors' descriptions of the children's emotional responses during progressively challenging activities could be identified as progressing through several stages of the Affective Taxonomy, including receiving, responding, and valuing. For example, in an activity requiring that they build Platonic solids out of materials of their choosing, the authors reported that the students began the activity without much enthusiasm, even complaining that it was too easy. As the children began to decide materials and construction procedures, they began to express realization that the task was more difficult than their first impression. As the children progressed through the project, they struggled and argued, but demonstrated an understanding that the process of collaboration on the project had worth. Upon completion of the icosahedron, the children expressed satisfaction in their accomplishment and participated in an animated discussion about rotation around axes of symmetry. This sequence of activities and responses suggested affective progression through Krathwohl's Taxonomy from receiving, through responding, to valuing (Krathwohl, Bloom, & Masia, 1964/1984).

In their research on a secondary genetics class, Hewson and Lemberger (1999) noted that students expressed arousal and expressions of satisfaction upon successful development of a model. This type of response indicated satisfaction with completion of a task, suggesting sub-level 2.3 Satisfaction in Response in which a learner often demonstrated an emotional response (Krathwohl, Bloom, & Masia, 1964/1984). Rosiek (2003) presented examples of teachers using their understanding of students' emotions to guide them from their initial low level of responding to a higher-level of value and kinship with other cultures. In one example, a teacher provided Hispanic students with a story that produced a sympathetic response in her students for problems encountered by Hispanic families who were forced out of their homes due to economic development. This example guided the students to transfer that sympathetic response to

experiences of Native American families in losing their land. In the process, the students developed a valuing response to the problems of Native Americans.

Table 2.2 Summary of Pertinent Literature for Affect and Learning

Study	Subjects	Method	Findings
Chory & McCroskey (1999)	108 college students enrolled in communications; Large East university	Quantitative Study Three self-measure surveys: teacher management and communication style, affective learning, and non-verbal immediacy	Feelings of trust in the teacher and interactive communication between teacher and student increased positive attitudes toward learning.
Isen, Daubman, & Nowicki (1987)	65 college students enrolled in Introduction to Psychology; Large East university	Quantitative Study Test of creative solutions: manipulation of materials	Positive affect participants produced significantly more solutions than neutral affect participants.
Aiken (1974)	190 college freshman men and women; Southeast college	Quantitative Study Two self-measure surveys of attitudes toward mathematics: enjoyment, value, interest, scholastic achievement	Enjoyment in and value of mathematics were two separate affective characteristics. Enjoyment showed positive correlation to mathematic ability and interest, while value was more related to high verbal and scholastic ability.
Nieswandt (2007)	73 ninth grade chemistry students; Germany	Quantitative Study; Three self-measure surveys during the year: interest in chemistry, self-concept, attitude toward chemistry, chemistry conceptual understanding	Interest in chemistry generated positive self-concept, which ultimately developed meaningful conceptual understanding.
Zusho, Pintrich, & Coppola (2003)	458 college chemistry students; Large Midwest university	Quantitative Study Three self-measure surveys during the semester: self-efficacy, task value, motivation, interest, anxiety, cognitive strategies, grades	As cognitive load on students increased over time, self-efficacy, motivation, and task value decreased. Interest and anxiety remained the same.

Table 2.2 Summary of Pertinent Literature for Affect and Learning, Continued

Study	Subjects	Method	Findings
Perrier & Nsengiyumva (2003)	29 Children age 9 to 18; Ruhengeri, Rwanda Unaccompanied Children Camp (UACC)	Qualitative Study Notes during preparation before the activity Observations during the activities Notes during debriefing sessions after the activity	Constructivist science activities led to the development of affective responses in children.
Hewson & Lemberger (1999)	30 secondary genetics students; Large Midwest high school.	Qualitative Study Transcripts of student comments and discussion during lesson activities	Students demonstrated affect and arousal during conceptual change.
Scharmann, Smith, James, & Jensen (2005)	19 science teacher education students; Large Midwest university	Qualitative Study Reaction papers Student comments during class discussions Nature of science evaluation Reflection essays	Reflection activity enhanced understanding of the nature of science. Continuum approach, immediate and respectful consideration of science/religion provided emotional scaffolding for conflicts with beliefs, contributed to successful learning.
Rosiek (2003)	20 teacher interns and 12 experienced science teachers; Large West Coast university	Qualitative Study Focus group discussions Examples of pedagogical practices	Emotional scaffolding was an effective pedagogical technique to support conceptual understanding.
McNerney, Soled, & Kukreti (2006)	Four secondary science teachers; Large Midwest university	Qualitative Study Focus Groups Journals Surveys	Teachers progressed through levels 1–4 of Krathwohl's Affective Taxonomy in a cyclical process while learning new pedagogical practices.

Theoretical Framework

In this study, the researcher used Krathwohl's Affective Taxonomy as the theoretical framework. In using the Affective Taxonomy as a framework for research, it is essential to analyze each level and the relationship between levels within the Affective Taxonomy. Krathwohl's Taxonomy of the Affective Domain was created as a system of affective categories of behavior for the development of affective educational objectives (Krathwohl, Bloom, & Masia, 1964/1984). As such, it identifies levels of affect and behavioral responses associated with those levels. For this study the researcher chose to use the Affective Taxonomy to identify student affective behavior as reported by teachers within levels of the Affective Taxonomy. In the following sections, each level is analyzed and interpreted in terms of thought processes, attitudes, and behavioral responses.

Level 1-Receiving

The Receiving level represents the sensitization of the learner to the characteristics of a topic (Krathwohl, Bloom, & Masia, 1964/1984). At this level, a key characteristic of learner behavior is compliance. A teacher introduces a science topic as way of knowing about phenomena that a learner encounters, and the learner becomes aware of the characteristics of the topic. At the lowest sub-level within Receiving, 1.1 Awareness, the learner is aware of the topic without recognition of the characteristics or even the ability to discuss the topic. At the second sub-level of Receiving, 1.2 Willingness to Receive, behavioral responses have progressed from paying attention to understanding patterns or characteristics of a topic of study. In sub-level 1.3 Controlled or Selected Attention, the learner understands the need to attend to certain aspects of a topic and moves beyond willingness to receive to directing attention to those characteristics of

study. Behavioral responses from the learner include listening, following directions and complying with the teachers' requests and directions.

Level 2-Responding

Responding, the second level of the Affective Taxonomy refers to the learner's active involvement in a topic (Krathwohl, Bloom, & Masia, 1964/1984). Key terms for describing behavior at this level are interest and cooperation. The learner has progressed from perceiving a topic to being actively involved in learning about a topic. In sub-level 2.1 Acquiescence in Responding, the learner agrees to take part in learning, while not fully accepting the reason for learning. The behavioral response from the learner is willingness to complete an assignment according to the requirements of the teacher. This particular level represents an incomplete area of affective development. A learner who remains at this level in learning a topic will never complete study assignments without external pressure. In sub-level 2.2 Willingness to Respond, the learner has developed an understanding of the reasons for the study, shows interest, and chooses to cooperate in the learning process. The learner's attitude is one of consent or cooperation, and behavioral responses include voluntarily studying and actively learning about a topic. Rather than needing an external stimulus as in 2.1, in sub-level 2.2, the learner consents to learning by choice due to an understanding for the need to learn. In sub-level 2.3 Satisfaction in Response, the learner has progressed from understanding the need for learning in sub-level 2.2 to satisfaction with learning. The learner gains a sense of pleasure or enjoyment of a topic, and the associated behavioral response is often emotional in nature. While emotional responses may occur at any level, in sub-level 2.3 they manifest without an associated value system or belief in the worth of a topic. A learner may get a thrill at an exciting demonstration or a feeling of satisfaction at completing a difficult assignment, but an overarching sense of recognizing the

value or worth of the topic is not evident at sub-level 2.3. An important consideration of sub-level 2.3 is that emotional responses can occur at low levels of the Affective Taxonomy and do not necessarily indicate development of value.

Comparison of Level 1-Receiving to Level 2-Responding

Level 1, Receiving differs from level 2, Responding in that the learner is aware of and listens to the topic in level 1 while in level 2 he is actively involved in learning about the topic (Krathwohl, Bloom, & Masia, 1964/1984). The learner has progressed from an attitude of wait and see to one of trying it out. The behavioral responses progress from describing a phenomenon in level 1 to actively learning about and eventually expressing an emotional response to the phenomenon in level 2. Educational activities associated with level 1 are basic and introductory, while activities at level 2 involve inquiry and synthesis.

Level 3-Valuing

The Valuing level of the Affective Taxonomy is a transition from cooperation and satisfaction in learning to the realization that a topic has worth (Krathwohl, Bloom, & Masia, 1964/1984). The learner evaluates topics beyond interest and recognizes the value of those topics. Level 3 also addresses the development of values and beliefs. At this level, the individual has an incomplete value system but feels strongly about and personally identifies with her beliefs. In sub-level 3.1 Acceptance of a Value, the learner's desire for understanding is due to recognition of the worth or value in understanding the topic. The learner has a positive attitude toward learning about a topic beyond the initial enjoyment. The learner views the learning as important and valuable and is personally willing to consider the topic at a deeper level. Behavioral responses at this level include seeking additional information about a topic or discussing it with others. In sub-level 3.2 Preference for a Value, the learner moves beyond

interest to actively pursuing the topic or activity that she considers valuable. She has taken on an attitude of greater commitment to the activity and will perform above and beyond the teacher's requirements. The learner initiates and pursues an active role in a desired activity and becomes an advocate to others for the area of interest. In sub-level 3.3 Commitment, the learner exhibits a drive and is motivated to accomplish a task, showing commitment to the area of interest. A characteristic that may appear at this level is a sense of "tension that needs to be satisfied" (Krathwohl et al., 1964/1984, p. 149). Behavioral responses include becoming deeply involved in the study of a topic, demonstrating an advanced understanding of a topic, and spending considerable time and energy in learning about or participating in an area of interest. The learner also considers and evaluates topics not only in terms of their value or worth as a meaningful topic of learning, but in association with personal beliefs and values. The learner expresses personal beliefs and demonstrates an attitude of "loyalty to a position, group, or cause" (Krathwohl et al., p. 149).

Comparison of Level 2-Responding with Level 3-Valuing

In comparing level 2 to level 3, the primary difference is the level of commitment by the learner to an area of interest (Krathwohl, Bloom, & Masia, 1964/1984). At level 2 Responding, the learner indicates an understanding of the need to learn about a topic and may indicate an enjoyment of the topic of study. At level 3 Valuing, the learner recognizes the worth of the topic and demonstrates commitment to learning about the topic. The learner also recognizes the relationship of the topic to personal beliefs and values. While emotional response or enjoyment may occur at both levels, at level 3, the commitment to the value of the topic is consistent.

Level 4-Organization

The term Organization for level 4 refers to the recognition by the learner of multiple relevant values and the need for a value system with a recognizable hierarchy (Krathwohl, Bloom, & Masia, 1964/1984). The learner engages in higher level thought processes about topics of learning and uses objectivity in making comparisons on topics that connect with values and belief systems. In sub-level 4.1 Conceptualization of a Value, the learner achieves the ability to consider values in the abstract and therefore compares new values to those that have already been internalized. The learner's attitude is one of consideration and comparative judgment. The learner is able to consider values associated with of a topic of study and compare them to the values that she already holds. While this process is similar to higher-level cognitive thinking, in sub-level 4.1, the response is in relation to the learner's values or beliefs. The learner evaluates topics in terms of their associated values and compares those values with the values that she has previously formed. In sub-level 4.2 Organization of a Value System, the learner displays objectivity in making decisions and solving problems. At this level the learner considers and compares a complex set of values and develops a hierarchy or relationship of those values. In this process learner creates a foundation or system of values or beliefs. Behavioral responses include the ability to examine a value, form judgments, defend a position, and recognize other individuals' values.

Comparison of Level 3-Valuing and Level 4-Organization

In comparing level 3 with level 4, the most important consideration is the development of the ability to compare values (Krathwohl Bloom, & Masia, 1964/1984). In level 3, the learner experiences a commitment to a cause or idea, in level 4, the learner understands that there are multiple ideas or causes that have value and compares values in order to place them within a

system of values. At level 3, the behavioral response is action on the part of the learner to understand or participate in an area of interest. In level 4, the behavioral response is showing evidence of high-level understanding of a value and the ability to objectively compare and contrast it with other values. The learner creates a value system by developing a hierarchy of values, rejecting earlier values, and adopting new ones.

Level 5-Characterization by a Value or Value Complex

In level 5, the learner has developed a hierarchy of values or value system and is able to use that value system to make judgments and solve problems (Krathwohl, Bloom, & Masia, 1964/1984). The learner is able to consistently act within accepted principles and values to make decisions. The attitude is one of an open mind to considering new ideas and values while remaining consistent with an established value system. Two aspects of behavior demonstrate characterization: (a) In sub-level 5.1, Generalized Set, a constant orientation or predisposition guides the individual's actions, and (b) in sub-level 5.2, Characterization, a consistent value system guides the individual's conduct. Learners exhibiting constant orientation guiding their actions show the ability to consider issues and problems objectively. With regard to a value system, learners with a consistent value system show a consistent code of behavior, exhibiting kindness, respect, and humility in their actions toward others. Krathwohl et al. (1964/1984) considered that the behavioral responses identifying sub-level 5.2, such as a commitment to a code of behavior in all phases of public and private life to be the ultimate goal of education.

Comparison of Level 4-Organization with Level 5-Characterization

In comparing level 4 with level 5, the key difference is in the consistency demonstrated in the behavior of the individual (Krathwohl, Bloom, & Masia, 1964/1984). In both levels, the focus is on a value system accepted and developed by the individual and how it is used to make

decisions and judgments. In level 4, the learner recognizes the need for development of a value system and compares internalized values with new values. In level 5, the value set has been crystallized to the point that it becomes a generalized set and characterizes the individual.

Summary

Studies on affect in education have focused on interest, attitude, and motivation (Garritz, 2010; Klopfer, 1976). However, as illustrated by Krathwohl's Affective Taxonomy (Tables 1.1 and 2.1), the affective domain encompasses multiple facets of human feelings, values, and associated behavioral responses (Krathwohl, Bloom, and Masia, 1964/1984). Behavioral characteristics of the Affective Taxonomy demonstrated evidence of differing levels of internalization of affect. Krathwohl et al. (1964/1984) called on researchers to investigate the types of classroom activities and interactions that produced affective responses.

The Affective Taxonomy provided a framework for the study of affective responses to educational topics and the creation of educational objectives to produce those responses. Evidence of the level of internalization of affect was exhibited in the types of behavioral responses toward topics of study. Krathwohl et al. considered reaching higher levels of internalization to be a goal of the educational experience. This study examined teachers' reports of students' affective responses and analyzed these data using the framework of Krathwohl's Taxonomy.

Chapter 3 - Methodology

This study investigated what types of student affective responses secondary science teachers reported, how they worked with those responses, and the interactions that occurred when science teachers worked with student affective responses. To explore how teachers reported and worked with student affect, the researcher used semi-structured, in-depth interviews and observations. The researcher used qualitative inquiry to discover and develop emergent themes associated with teachers' use of affect in the secondary science classroom.

Research Design

This study used a qualitative, case study approach. According to Creswell (2013b), qualitative research is characterized by the location of the study in a natural setting, an emergent research process, and a theoretical lens. Qualitative researchers use multiple sources of data, building meaning through an inductive process that leads to representative themes (Creswell, 2013b). While participants' meanings were the focus of this study, the researcher in this study used her background and experience to interpret and understand emerging themes (Creswell, 2013b). The researcher looked for intricate and complex ideas and meanings, relying on the participants' interpretations of their work as science teachers (Creswell, 2013a; Stake, 1995). A qualitative approach supported the researcher's desire to listen to science teachers and understand their meanings while interpreting their ideas and analyzing emerging themes through the theoretical lens of Krathwohl's Affective Taxonomy.

As a qualitative strategy, the researcher selected the case study to explore in depth the participants' understandings and interpretations of the issue (Creswell, 2013a). Use of a case study approach allowed the researcher to develop a deep understanding of the "uniqueness and complexity" of the case (Stake, 1995, p. 16). The researcher explored participants' relationships

and interactions within the circumstance and environment of the case (Stake, 1995). In this study, the case was made up of multiple participants identified as graduates of the secondary science teacher education program at the Kansas State University College of Education. The researcher chose the single case study approach in order to use multiple participants with a common experience representing the boundary of the case (Stake, 1994, 1995). The science teachers participating in this study shared a common experience through their education in that all completed the secondary science teacher education program at Kansas State University.

Purpose of the Study

The purpose of this study was to examine the types of student affective responses that secondary science teachers reported emerged in science classes, how teachers worked with student affective responses, and what interactions were present in the classroom when teachers worked with student affective responses. Participant science teachers' reports of types of student affective responses were identified and evaluated in terms of Krathwohl's Affective Taxonomy. Descriptions of ways that participant teachers worked with affect and interactions that occurred were examined to develop emerging themes. The researcher examined participant science teachers' ideas and understanding of their students' behavioral responses to identify behavior representing levels within Krathwohl's Affective Taxonomy. To further develop an understanding of the use of affect in the secondary science classroom, the researcher examined participant teachers' reports and use of student emotion, attitude, and values based responses in science classes with a view toward revealing topics for future research.

Research Questions

The overarching question guiding the study is: What affective responses do secondary science teachers report, and how do they work with those responses as identified by Krathwohl's

Taxonomy of the Affective Domain? Related to this overarching question are the following more specific research questions used to focus this investigation:

1. What types of student affective responses, as identified by Krathwohl's Affective Taxonomy, do science teachers report emerge in science classes?
2. How do science teachers work with student affective responses, as identified by Krathwohl's Affective Taxonomy, in teaching science?
3. What interactions do science teachers report are present in the classroom when they work with student affective responses as identified by Krathwohl's Affective Taxonomy?

Krathwohl's Taxonomy of the Affective Domain is a classification system of affective behaviors representing the types of "human reaction or response to the content, subject matter, problems or areas of human experience" that reveal or call attention to "feeling, tone, an emotion, or a degree of acceptance or rejection" (Krathwohl, Bloom, & Masia, 1964/1984, pp. 3, 7).

Role of the Researcher

In a case study, the researcher must assume a critical role beyond designing the study and collecting and analyzing data (Stake, 1995). Initially, the researcher may choose the case based on an emotional or personal interest in the issue of study or in the persons making up the case (Berg, 1998). During the field work the researcher must position herself in a way that will produce the most productive results: removed from the case to avoid inadvertently affecting the dependability, but close enough to maintain credibility (Creswell, 2013b). The researcher must acknowledge and use her background to guide interpretation and develop advocacy (Creswell,

2013b). As understanding of the case develops, the researcher uses her background to understand and interpret data in ways that produce valuable meaning about the issue of study.

The researcher in this study acknowledges a personal interest in this case due to her background as a secondary science educator and teacher. The researcher's personal interest must be acknowledged in relationship to her knowledge of the participants, her experience as a science educator, and her selection of the topic. The researcher taught, observed, or supervised some of the participants in this study in her position as their secondary science education methods instructor and university supervisor during their teacher education experience. Part of the education in the methods class included learning strategies and techniques to reach and recognize student affect. Teachers learned to respect and acknowledge students' strong emotions, religious values, and viewpoints about science theories including evolution, geological time, and the origin of the universe.

As a former secondary science teacher, the researcher has professional experience in the concerns and challenges that science teachers face in an age of increasing emphasis on cognitive development in the science classroom. She gained experience and understanding of the role of emotions, attitudes, and values in science learning during her time as a classroom teacher. The researcher used her background and experience to choose the topic and determine the case. The researcher noted from her experience that teachers used the affective domain in planning lessons and creating activities. Maintaining student interest required an understanding on the part of the teacher about how to reach students' internal attitudes and values. Over time, guided by a skillful teacher, some students developed a keen interest and drive to gain more knowledge in the topic.

The researcher believes attention to cognitive development in education has come at the expense of development of ability and expertise in reaching the affective dimensions of student

development. In her experience, creating opportunities for affective response in the study of science contributed to student interest in science. During the course of this study, the researcher sought to consider and reflect upon these assumptions and biases throughout the study to allow open and honest responses from participants and to communicate accurate results. While the researcher acknowledges a strong connection with the participants' positions as science teachers, she recognizes that they have unique experiences that are valuable for this study. She acknowledges that interpretation, while influenced by her background, must reflect the participants' viewpoints and contributions to the study.

Selection of the Case

The selection of a case is made because a researcher believes in her ability to interpret and develop meaning about an issue (Berg, 1998). While a researcher may have interest or experience in the issue, that experience should strengthen her ability to develop and interpret the complex meanings of the case (Marshall & Rossman, 2006). The researcher identified the case for this study as practicing science teachers who graduated from the secondary science teacher education program at Kansas State University between 2006 and 2011. The issue in the case was teacher recognition and use of students' emotions, attitudes, and values in science education. The researcher's selection of this group of secondary science teachers for the case was based on their common experience in the secondary science teacher education program at Kansas State University. All teachers who completed the program had taken Science Methods for Secondary and Middle Schools and Laboratory Techniques in the Teaching of Science. In the science methods and laboratory techniques classes, science teachers were educated in methods that allowed students to express and identify their attitudes, emotions, and values in the study of science. Instead of avoiding topics that were perceived as controversial or that might encroach on

students' personal and religious beliefs, teachers were encouraged to approach these topics with respect for students' ideas and beliefs. The teachers learned to encourage students to talk about their emotions and values in a non-threatening and supportive environment (Fried, 2007; Woods & Scharmann, 2001). This approach was intended not only to allow students to talk freely about topics that they felt strongly about, but to improve learning by creating an environment that encouraged them to be able to discuss and explain how these topics related to them personally (Scharmann, 1994, 2005; Woods & Scharmann, 2001). While the term affective domain was used rarely, the teachers were aware of research indicating that addressing emotions, attitudes, and values along with cognitive requirements enhanced student interest and learning.

Participants

For this study, the researcher used criterion and purposeful sampling to select participants that could provide the greatest understanding and meaning (Merriam, 1998). In using criterion sampling, the researcher selected participants with a common experience in the subject of the study (Creswell, 2013b). Participants in this study had all completed secondary science teacher education program at a Kansas State University from 2006 to 2011, and all shared a common experience in learning about the use of affect during their science methods and laboratory techniques classes in the secondary science teacher education program. For purposeful sampling the researcher selected from teachers in the sample population who were teaching secondary science during the study and that the researcher believed were the most responsive (Stake, 1995). The researcher identified 32 secondary science teacher education program completers and invited them to respond to an initial selection questionnaire (Appendix A). Eighteen program completers who were practicing secondary teachers responded to the questionnaire. The researcher examined their responses and identified teachers as potential participants that she

believed could provide the best descriptions and explanations of their experience working with student affect. The researcher identified these teachers as potential participants because they had provided (a) detailed descriptions of student activities and examples of student affect, and (b) they were able to describe behavioral responses that the researcher could identify as representing levels of student affect. The researcher also identified potential participants representing a variety of content teaching areas: biology, chemistry, physics, and earth science. The researcher ultimately selected eight teachers, five men and three women, with from two to six years of teaching experience who agreed to participate in the study. These eight participated in semi-structured in-depth interviews (Appendix B) that were followed by classroom observations and debriefings. Additional potential participants were designated if more interviews were needed; however, saturation was achieved with the eight participants.

Data Collection

The qualitative study requires multiple interviews, observations, and documents from the case to provide a comprehensive examination of the study (Berg, 1998; Creswell, 2013b). The credibility of the case study requires that these data provide the rich, descriptive detail considered essential for qualitative studies. As recommended by Berg (1998), the researcher collected detailed data from multiple sources creating a foundation from which to develop informed interpretations and assertions. Data were collected during the study in the form of interviews, observations, debriefings, field notes, and teaching and learning artifacts. All data were collected in 2013.

The researcher conducted semi-structured interviews with each of the selected participants (Appendix B). The questions asked about activities and lessons occurring in participants' classrooms and the student behavioral responses that participants had observed. The

interview questions were designed to prompt participants to describe affective behavior they had observed from their students. Prior to the study, three professional teachers not participating in the study reviewed the questions. Using their comments and suggestions, the interview questions were revised for the study. The intent of the interview was to hear participants' experiences about affective behavior that they observed in their students during science lessons. Participants were encouraged with prompts and follow up questions to provide thick, rich descriptions about their experiences in working with student affective responses. When possible, the interviews were conducted in the participants' classrooms outside of school time. The researcher believed that the classroom setting provided an environment that allowed participants to focus on their roles, teaching styles, and strategies (Berg, 1998; Creswell, 2013b). The researcher added notes to the record of the interview, including demographic and teaching assignment information about the participants. Following the interview, the researcher added observations and insights to the interview record. Participants were invited to review their interview transcript and make clarifications or corrections.

The researcher observed participants' classes to add to the knowledge and develop an understanding of the lessons and activities that the participants used. Classroom observations allowed the researcher to observe participants and students in their natural setting and develop a greater understanding of their reports of student affect (Creswell, 2013b). The researcher scheduled observations for two or more class periods of the participants' classes, and returned for additional observations in three of the participants' classes to observe more activities. For observations, the researcher recorded field notes containing the date and time, place, participant, content area, and notes about the activities and behaviors observed (Creswell, 2013b; Merriam, 1998). The researcher described activities, discussions and conversations along with behavioral

responses of students throughout the observations (Merriam, 1998). Following observations, the researcher conducted a debriefing with the participants, discussing what had occurred and asking for clarification. After observations and debriefings were completed, the researcher added additional insights to the observation field notes (Appendix C). Data for a qualitative study include artifacts that support the interviews and observations (Creswell, 2013b; Stake, 1995). In this study, the researcher obtained student work and instructional activity samples provided by the participants. The researcher assured the participants that no student work would be used in the paper. These teaching and learning artifacts were used only for triangulation with other data collected in the form of interviews, observations, and notes.

Prior to beginning the study, the researcher obtained approval of the study from the Institutional Review Board (IRB, Appendix D). As stated in the IRB, identity of participants in the study is confidential and their responses will not be identified with them in any way. The participants received a letter of invitation with a statement of research explaining confidentiality and the right to withdraw from participation at any time (Appendix E). All references to participants in the study were in the form of pseudonyms. All school and student identities were kept confidential. Student work was used only for triangulation. All documents, digital audio recordings, and computer data are secured in the researcher's office and are accessible only to the researcher. Documents are stored in a locked file cabinet and all computer data including digital audio recordings are stored on a secure password protected hard drive in the researchers' office. Documents and data will be kept locked for a period of three years, after which they will be destroyed.

Data Analysis

The researcher used a data analysis spiral to organize, manage, and analyze data (Creswell, 2013b). The data analysis spiral began with organizing and managing data, followed by reading, reflecting, classifying and categorizing data. The researcher used categorical aggregation, direct interpretation, and naturalistic generalizations of data as strategies to develop emerging categories of information (Creswell, 2013b; Stake, 1995). In the initial process of categorical aggregation, data were coded using NVivo 10. The researcher coded affective responses from participant interviews, observations, debriefings, and teaching and learning artifacts within the framework of Krathwohl's Affective Taxonomy using affective levels as codes. Following this initial coding, the researcher followed Creswell's (2013b) recommendations of direct interpretation, performing a second round of coding using open coding to develop emergent themes and subthemes. After this process of open coding, the researcher examined the codes for relationships. Codes considered redundant or related were eliminated or merged. The researcher used naturalistic generalizations in the development of emergent themes. After creating emergent themes, the researcher read transcripts and notes again, looking for confirmation of her interpretations of emergent themes within participants' reports (Creswell, 2013b). This analysis was recorded in the researcher's NVivo project and in notes summarizing types of responses interpreted as emergent themes.

Trustworthiness

Trustworthiness in the case study was maintained through design of the study to address credibility, transferability, dependability, and confirmability. According to Lincoln and Guba (1985) credibility assured that the data and findings were truthful. Transferability indicated that the findings applied to other contexts or populations. Credibility and transferability established

the accuracy and generalizability of the study, and dependability ensured that the study could be replicated with similar subjects and contexts. Confirmability ensured that the respondents and not researcher bias, motivation, or interest shaped the findings of the study. Design specifications developed to ensure trustworthiness are presented in the following paragraphs.

Ensuring the credibility of the study required that observations and measures reported in the study were accurate and truthful representations of the phenomenon (Lincoln & Guba, 1985). To ensure credibility, the researcher used prolonged engagement, member checking, triangulation, and peer debriefing. The researcher conducted multiple interviews and observations of participants, to confirm and refine ideas and findings. Information from interviews was confirmed during classroom observations, and the researcher debriefed participants after observations to ensure that the researcher developed an accurate understanding of the participants' meanings. The researcher invited participants to read and confirm their interview transcripts. Participants were invited to comment, clarify and provide corrections to the transcripts. The researcher triangulated data by examining transcripts and notes of interviews, observations, debriefings, and teaching and learning artifacts to develop and verify emerging themes. The researcher's major professor and the researcher engaged in peer debriefings to ensure sound methodology and practices during the study.

The transferability of the study was addressed through a "thick description" where the researcher described patterns of interaction within the time and context of the research (Lincoln & Guba, 1985, p. 136). The researcher described the research and findings in detail to allow the reader to determine whether the research generalized to another setting. In this study the researcher provided concentrated descriptions of the participants' reports, ideas, and viewpoints and the interactions that occurred within the study. These thick descriptions presented

information allowing practitioners and researchers to determine transferability of the findings to other contexts (Denzin, 1994)

The dependability of a qualitative study relied on demonstration of credibility. However additional techniques such as “overlap”, “stepwise replication, and “inquiry audits” established dependability as well (Lincoln & Guba, 1985, p. 317). For this study the researcher maintained dependability primarily though establishment of credibility. Further the researcher addressed dependability through development and documentation of the process of the study and collection of data along with development of the findings and interpretations.

Confirmability of the qualitative study was established through preserving data, documenting the process of the study, and organizing the development of findings and interpretations of data (Lincoln & Guba, 1985). The researcher preserved interviews, transcripts, field notes, debriefing notes, audio recordings and student work examples. The researcher created detailed notes of the progress of data collection and used NVivo for electronic organization of data during the analysis. All data, notes, artifacts, and the NVivo project are secured in the researcher’s office.

Summary

In this study, the researcher used qualitative research methods to answer the following questions:

1. What types of student affective responses, as identified by Krathwohl’s Affective Taxonomy, do science teachers report emerge in science classes?
2. How do science teachers work with student affective responses, as identified by Krathwohl’s Affective Taxonomy, in teaching science?

3. What interactions do science teachers report are present in the classroom when they work with student affective responses as identified by Krathwohl's Affective Taxonomy?

The researcher selected qualitative case study to allow participants to contribute their own ideas and interpretations of their experiences (Creswell, 2013a, 2013b). The theoretical framework for the study was Krathwohl's Taxonomy of the Affective Domain (Krathwohl, Bloom, & Masia, 1964/1984). Within this chapter, the researcher identified the method of research design including selection of the case participants, explanation of the setting, the interview process, and the methods used in data analysis. The researcher collected and analyzed data using the recommendations of Creswell (2013b), Lincoln and Guba (1985), and Stake (1995). Trustworthiness was ensured through processes of credibility, transferability, dependability, and confirmability using prolonged engagement, member checking, triangulation, and peer debriefing, along with thick description and development of an audit trail (Creswell, 2013b; Denzin, 1994).

Chapter 4 - Findings

In this qualitative case study, the researcher examined secondary science teachers' reports of the types of student affective responses that emerged in science classes, how these teachers worked with student affective responses, and what interactions were present in the classroom when teachers worked with student affective responses. *For this study, the participants were secondary science teachers. Throughout the chapters on findings and conclusions, participants are referred to as teachers.* The researcher used teacher interviews, classroom observations, field notes, and teaching and learning artifacts as data sources. The interviews were semi-structured, allowing the researcher to prompt teachers for descriptions and interpretations of affect and learn reasons for those accounts. To analyze the data, the researcher examined the data to identify behavioral responses representing levels of Krathwohl's Affective Taxonomy. The researcher coded the data using NVivo 10, creating nodes representing affective levels and categorizing teachers' reports of student affect within Krathwohl's Taxonomy. Following this initial coding, the researcher performed a second round of coding to develop emerging themes and subthemes. The researcher examined resulting codes for emergent themes and identified an overarching theme of *teachers working with student affect through interaction*.

In this chapter, the researcher begins with a brief description of the teachers participating in the study and a discussion of these teachers' reports of affect in the context of their educational background and their understanding of affect. The findings follow in two sections, (a) categorization of student affect within Krathwohl's Affective Taxonomy and (b) emergent themes. In categorization of student affect, the researcher presents teachers' descriptions of affective behavior within the framework of the Affective Taxonomy. In emergent themes, the researcher discusses the themes and sub-themes developed from analysis of data.

Teacher Participants

Eight secondary science teachers, three women and five men, formed the case analyzed for this study (Table 4.1). These teachers received their science education through the Kansas State University Science Education program, and all were practicing science teachers with two to seven years of teaching experience. Science content areas represented were biology, chemistry, physics, and earth science. During the study, all were teaching in public schools and represented a variety of high school sizes from less than 200 to over 2000 students. For this study, the participants were referred to as teachers and identified by pseudonyms.

Table 4.1 Teacher Participants

Pseudonym	Gender	Content Area
David	M	Biology
Ellen	F	Physics Earth Science
Eric	M	Biology
Greg	M	Biology
Jane	F	Physics
Jeff	M	Chemistry Earth Science
Louis	M	Biology
Sarah	F	Biology

The teachers in the study shared a common experience through their teacher education program. All had participated in Science Methods for Secondary and Middle Schools and Laboratory Techniques in the Teaching of Science. In these classes teachers were taught to

present science through multiple holistic dimensions using aesthetic, historical, and philosophical aspects. Science topics considered by some students to be controversial, such as theories of evolution, geological time, and the origin of the universe, were presented in the context of the nature of science. Teachers addressed student concerns about the origin of life and the universe with open conversations on personal and religious values. Studies of this educational practice suggested that allowing students to discuss their personal and religious beliefs early in the study of perceived controversial science topics was an effective method for creating a favorable classroom climate for the study of these topics (Scharmann, 1994, 2005). The need for understanding the attitudes and interests of students in a high school science classroom was addressed in the science methods and laboratory techniques classes, but the affective domain was not a part of the science methods curriculum. Teachers in this case study were familiar with the term affect, but not familiar with Krathwohl's Affective Taxonomy prior to the study.

Teachers' Reports of Student Affect

In choosing to examine these teachers' reports of student affect, the researcher believed that observations by teachers represented an effective and reliable way of reporting affective behavior in the classroom (Kearney & Beatty, 1994). As continuous observers of student behavior and the results of that behavior, the researcher considered science teachers to be experts on student behavior in the science classroom. It was the intent of the researcher to document teachers' reports of affective behavior in their own words, without the use of Krathwohl's Taxonomy. Therefore, no reference to Krathwohl's Affective Taxonomy was made until the interview. The interview questions asked about activities and lessons occurring in teachers' classrooms and the student behavioral responses that teachers had observed. Teachers described

their observations and interpretations of student affect within the context of lessons, activities, and interactions.

Findings

In this section, findings are presented as (a) categorization of student affect and (b) emergent themes. In the section, *Categorization of Student Affect*, the researcher categorized teachers' reports of types of student affective responses using Krathwohl's Affective Taxonomy as a framework to answer research question 1, *What types of student affective responses, as identified by Krathwohl's Affective Taxonomy, do science teachers report emerge in science classes?*

The researcher identified five emergent themes that answered research questions 2 and 3: *How do science teachers work with student affective responses, as identified by Krathwohl's Affective Taxonomy, in teaching science?* and, *What interactions do science teachers report are present in the classroom when they work with student affective responses as identified by Krathwohl's Affective Taxonomy?*

In the analysis the researcher coded and recoded data looking for emergent themes. In this process, the researcher found that questions 2 and 3 were interrelated in that teachers used interactions in the classroom to work with student affect. As a result, the researcher identified an overarching theme of *teachers working with student affect through interaction*. Within that overarching theme, the researcher found the following emergent themes:

1. Teachers used affect to gauge student attitudes and improve instruction.
2. Teachers managed student affect in the study of perceived controversial science topics.

3. Teachers used collaboration during classroom activities to move students from receiving to responding behavior.
4. Teachers used conversation in the classroom to improve student attitude.
5. Teachers helped students move through affective levels from receiving into responding and valuing behaviors.

The following discussion of the findings includes quotations and details from interviews and observations in support of those findings. To allow the reader to understand the experiences of the teachers, the researcher created an account of the broad range of reports of teachers using "thick description" (Denzin, 2001, p. 41).

Categorization of Student Affect

Krathwohl, Bloom, and Masia (1964/1984) defined affective behavior at five levels in the Affective Taxonomy: (a) receiving, (b) responding, (c) valuing, (d) organization, and (e) characterization. Within those levels, Krathwohl et al. (1964/1984) described affect in two ways: as a psychological construct and as student affective behavior that occurred in an educational setting. In this section the researcher classified affective behavior of students as reported by their teachers within all levels of the Affective Taxonomy based on Krathwohl et al.'s descriptions of student behavior representative of a particular level in the Affective Taxonomy. All eight of the teachers in the study gave examples of behavior that the researcher classified within the first two levels of the Affective Taxonomy, receiving and responding. Six of the eight teachers identified behavior that the researcher classified within the valuing level. Five of the eight identified behavior that the researcher classified within the organization level, and three teachers identified examples of behavior associated with the characterization level. Affective behavior reported by teachers and identified within levels of Krathwohl's Taxonomy is shown in Table 4.2. Teachers

reported student affective behavior in various modes including expressing enjoyment through smiles and lively conversation; showing interest through questions, comments, and eye contact; and demonstrating frustration with verbal statements, body language, and facial expressions.

Table 4.2 Affective Behavior Reports by Teacher

Teacher (Pseudonym)	Affect Level Described				
	Receiving	Responding	Valuing	Organization	Characterization
David	√	√	√	√	
Ellen	√	√	√	√	√
Eric	√	√	√		
Greg	√	√		√	√
Jane	√	√	√		
Jeff	√	√			
Louis	√	√	√	√	
Sarah	√	√	√	√	√

Levels of Affect

Receiving. Krathwohl, Bloom, and Masia (1964/1984) identified the receiving level as the lowest level of affect. According to Krathwohl et al. (1964/1984), student behavior in the receiving level indicated an awareness of topics of instruction and a willingness to listen. Affective behavior at the receiving level was similar to cognitive behavior in that the students were doing little more than reading or listening. In describing typical receiving level behavior Krathwohl et al. observed that students showed low interest in a topic but were willing to pay attention to it.

All eight teachers reported behavior that the researcher classified within the receiving level. In their descriptions of activities that prompted receiving behavior, teachers described basic reading and note taking in the context of creating a foundation of knowledge. They discussed student responses at the receiving level in association with initial learning about a topic before moving on to applications. In these descriptions teachers reported observing students' initial lack of interest, divided attention, and tendency to put little effort into their assignments. Greg described his students working on introductory activities and noted their tendency to socialize indicating that they did not give all of their attention to the assignments. In the following quotation, he explained their behavior in the context of introductory activities:

> We usually do bell work when class started. And I would give them steps of what we would be doing, my expectations and goals for what we would be learning for the day. We used the 5E model. The teachers as a whole [in his school] used it. In the explain stage [the first step of the 5E instructional model], I would give them the background information. Sometimes we would follow with a lab, sometimes an activity, identifying animals and plants as an example.
>
> While they were doing their work, it was more important to them to socialize than to do their tasks. They would do their work but there were other issues that were more important to them. You could say they were halfway interested. They would listen when I would give them the steps we were going to do for the day. Then I would break them into groups. It was when they got into groups that they were working on task, but they were also socializing. (Greg)

In the previous quotation, Greg described his students as "halfway" interested in their assignments, noting they were listening but socializing while working on their required tasks.

Jane commented that her students performed well at the receiving level when they followed her specific assignment directions that she described as a rubric. In her account of student behavior at the receiving level, Jane explained that her students required specific direction:

> They want to know exactly 'what you want me to do.' They are willing to do whatever you want them to do as long as you tell them exactly what to do and how to do it. … I think they just go through the motions as we start on a unit. They do as little as they can. (Jane)

Jane concluded that her students were willing to work on their assignments if she provided specific, detailed instructions, noting that they put little effort into assignments. Similarly, Jeff described students requiring direct instruction:

> They didn't want to do the assignments. When I would try to discuss it, they would change the conversation. They wanted me to tell them everything they needed to know. … They are very good at getting the information out of you, getting you to help them finish their assignments. But when it came time to take the test, they did very poorly. (Jeff)

In this quotation, Jeff explained that his students wanted him to provide basic knowledge. Their interest was in finishing their assignments rather than learning. As a result, they did not perform well on their tests.

Ellen described requiring students to take notes to build their foundation knowledge: "One of the things I have been using is keeping a notebook as an additional source of information." In describing students' responses to taking notes, she reported that her students were aware of the requirements, but not yet interested in the topic: "I think they understand the

requirements and objectives. But they aren't yet bought in. … I think they were getting it at the level that I needed them to get it." The researcher observed this behavior during an observation of one of Ellen's classes. Students did not appear to be interested in the note taking activity based on their reluctance to get out their notebooks and their indifferent expressions when she asked them to take notes, but they complied with her request. Other teachers also described students initially appearing unenthusiastic about introductory learning activities. Sarah reported students not giving their full attention to the assignment: "They are definitely multitasking. If they can get away with it they will be doing something else. If their phone has games on it then they get the games going underneath the table." These descriptions paralleled Krathwohl's observation that students working at the receiving level were aware of a topic but "couldn't care less about it" (Krathwohl, Bloom, & Masia, 1964/1984, p. 101).

In reporting student behavior at the receiving level, Sarah described her students reading introductory information and taking notes while reading about animals on a website. In her description she reported her students' lack of interest and divided attention:

> The first project that I give them, they may only do the basics. Because as far as some of them are concerned, they're not going to get an A anyway. They're not going to get anything out of it; they just want to get it done. So they may sit there and just write down the basic work and then try to trick me into thinking that I'm not seeing that they are trying to go to [computer] games [The students were to read an assigned Web site and take notes. During this activity, they tried to access computer games without Sarah noticing]. But I'm walking around and watching them constantly. So if I see them on the wrong [web] page, they have to go back. [Sarah prompted them] 'Well, did you find this information? Well, tell me where do they live?' or 'What is the weather like there?' to get

them engaged. And once they are engaged and know that we are interested in what they are finding, they tend to show that they understand the topic beyond the basic assignment requirements. But what they write is still only what they think they can get away with. (Sarah)

In the previous passage, Sarah described the process of introducing a topic and working to develop student interest by moving around the room and talking to each one. She noted that her students' attitudes indicated low interest and lack of confidence in their ability to get a good grade. She explained that her students were beginning to show a willingness to pay attention and accept information about the science topic she wanted them to learn. She also reported that they were beginning to develop an interest in parts of the topic but they only completed the basic requirements of the assignment. Sarah's observation was supported by Krathwohl, Bloom, and Masia's (1964/1984) statement that as students became familiar with a topic they showed willingness to listen and developed some interest in a topic. The researcher observed this student behavior in her observation of Sarah's classes after her interview. The students initially appeared to be at the lowest level of receiving, not showing interest and trying to multitask. As Sarah moved around the room and talked to them about their work, they began to listen and comply with her request.

Louis also described behavior suggesting emerging student interest. He noted that his students began to show behavior indicating a developing interest. Louis described his students during their initial research about an environmental issue:

The first half [of the unit of study] was just research. I had articles for them to read. In the beginning that's what they did. We just read about that issue. … And I kept stressing to the kids that these are good articles. I picked a variety of resources. They did balk at it at

first and it was a bit of a struggle. But they started to get into it more as they went along. (Louis)

Similarly, David described his introductory reading assignments designed to gain foundation knowledge: "They have textbooks on line. They read their assignments at home. I give them articles. I don't have them read high amounts. I have them take notes." Over time, his students developed a willingness to read the articles: "At first the students don't want to read it. But we discuss it and do a preview of it. Before you know it, through the discussion, a lot of them will catch on to the discussion and want to read the article."

Greg made comparable comments about working with introductory material at the receiving stage and noting that his students began to show interest:

> First we had to learn the basics of the terminology. Just identifying the kingdoms of animals and plants, just identifying. Then we would learn about the organisms and that's where the science principles came in. Like the animals, traits, and behavior, habitat. And that's where they started to get more interested, more focused. (Greg)

David explained that basic activities prepared students for more advanced activities to follow: "We had a lot of background. We spent last semester talking about cycles. We had prepared for the topic." In this quotation David described the basic introductory activities that prepared his students for the ecosystem project that followed. In that project David's descriptions of his students' behavior indicated they progressed to a willingness to respond. The responding behaviors that he and other teachers observed in their students are discussed in the next section.

Responding. In Krathwohl's Taxonomy, student behavior at the responding level progressed from willingness to work on assignments to active interest and participation in a topic

of instruction. According to Krathwohl, Bloom, and Masia (1964/1984), common student behaviors at this level were willingness to work without pressure from the teacher, expressions of enjoyment in activities, strong emotional responses to the topic, and satisfaction in accomplishment. All eight teachers in the case reported behavior that the researcher identified as responding. In their reports, students were described as starting or continuing class work and assignments on their own without pressure or prompting from the teacher. Assignments that produced this response tended to be projects, or applications that required use of the knowledge acquired from introductory lessons. As students worked on these activities teachers reported that students developed more interest demonstrated by showing enjoyment and satisfaction with their accomplishments. Teachers also reported that students demonstrated strong positive emotions.

Sarah described her observations of students becoming interested and showing a willingness to work on assigned activities without pressure. She observed that over time the students began to work on assignments quickly, and their "noisy" voices indicated they were responding with positive affect to the activity:

> At the beginning of the semester when I give a project, it's kind of slow going. As we go through the semester, they dig into it faster. I will see them immediately bring the computers out and go and start work as opposed to taking their time, messing around. And this is really general because I have classes where kids won't do that. [In this statement, Sarah commented on the class as a whole but pointed out that there were some individual students who did not behave this way.] But in general as the semester goes on, they'll dive more and more into what's going on. And that will be my measure of what kind of interest they are developing, how much they care about the topic and how they feel about their ability to do the assignment. When I've got them with me [when they are

active and interested in the assignment] it gets to be noisy because I encourage them to talk to each other, to share with each other. (Sarah)

In this example Sarah used the phrase "when I've got them with me" to indicate that she believed her students were developing an interest in the topic. She believed that when students developed interest, they showed their enthusiasm by getting to work on the assignment quickly without prompting and by becoming noisy and talkative.

Other teachers reported students showing behavior indicating positive affect, particularly enjoyment. They also described students as self-starters, becoming noisy and talkative as they became more comfortable in the classroom and interested in the topic.

Jeff commented on his students' attitudes indicating interest, noting how they showed enjoyment and enthusiasm, "They are happy! They do their assignments right away. They are talking to each other. They are enjoying themselves, working together. You even see some high fives."

When asked what type of behavior he observed as his students developed interest in an assignment, David reported:

> Enjoyment. They come to life, their faces, the way they talk to each other.… I can sit at my desk and watch them come in, and they want to see how [a fish that has survived the longest in a student created ecosystem] is doing.… They like to talk to each other and to me about it. (David)

Greg described his students changing from apprehension to staying on task and self-starting behavior in a dissection lab:

> Well some of them were a little apprehensive at first. Once they got the opening and when I demonstrated how to cut the cat and get into the internal organs. Some of them

were really apprehensive. Once we got the cat laid out, then they figured out it wasn't quite as bad as they had thought. When they got into it on their own, I didn't have to push them any further. They pretty much all stayed on task. I didn't have to do much running around figuring out what they were doing. They all stayed on task.…They were very talkative, but very busy working on the activity. (Greg)

The researcher observed responding behavior indicating positive affect and enjoyment in five teachers' classes. An observation of Louis's classes was typical. The researcher saw students working on a plant identification lab in groups, moving through stations and examining different plant samples at each station. Prior to the observation, Louis explained that the students had started working on an activity earlier in the week and would be continuing that activity during the observation. He explained that they would show their interest by coming in eager to work on the activity. Their enjoyment in the activity would be apparent from their noisy talk and expression throughout the activity. During the visit, the researcher observed responding level behavior just as Louis had predicted. The students entered the classroom and began immediately working collaboratively without prompting from the teacher. The classroom became noisy as lively conversations about the topic occurred between the students, and facial expressions were smiling, alert, and focused. The researcher observed similar behavior in Sarah, David, Ellen, and Jeff's classes, as well.

Teachers identified strong positive emotional responses and expressions of excitement occurring as students recognized completion of a task and enjoyed satisfaction in accomplishment. Common exclamations from students were, "Wow this is cool!" (Louis) or "I get this!" (Jeff). Fist pumps and high fives occurred frequently in teacher accounts of students celebrating accomplishments. When asked what she saw as strong responses from her students,

Ellen noted students exclaiming, "'We got it!' High five each other, get to talking with each other, real excited." Similarly, Louis commented on observing students expressing excitement at accomplishment, "Well, there was joy.… They just got a kick out of being able to do it."

When asked if her students showed satisfaction in accomplishment of an activity, Ellen described her students' excitement at developing conceptual understanding:

> Usually it's in hands on stuff where they are setting something up or turning a prism just right so that you actually get the rainbow of colors, because that will take quite a bit of tweaking where you actually get that result. I had some classes get real excited when they were able to get that. Some kids get very excited when they have been able to figure out how something works conceptually. (Ellen)

In her comment Ellen noted that students were not only excited at accomplishing the activity, but also at developing an understanding of a physics concept.

Three teachers distinguished between excitement in accomplishment, and that of a thrill in watching a demonstration, such as an explosion. Students' strong emotional responses at "blowing stuff up" were not associated with the emotional responses that accompanied satisfaction in accomplishment. Jane explained, "Kids like to blow things up, but they don't care about the chemical reactions. That's just more of a fun thing to do, not really something they are excited about." Similarly, Jeff commented, "I can take them into the lab and show them some demonstrations that they like. Blowing stuff up, that usually gets their attention. … I don't know if I see that as really being excited about an activity." Eric explained the need for connecting strong demonstrations into lesson content, or the students' excitement would be short-lived:

> Mixing hydrochloric acid and aluminum is a thrilling chemical reaction, but unless you can get them to focus on what you are looking at there is not much point to it. So you can

> get the thrill and the fizz and the pop, you know, possible explosion. That's what they are looking for. But after that it's done, it's over, and they are ready to move on to the next thing.…You have to tie it in. In and of itself, it's not strong enough to make an impression. (Eric)

The researcher believed that this distinction between a "fun thing to do" and "something they are excited about" supported Krathwohl, Bloom, and Masia's (1964/1984) findings on the difficulty of classifying an "emotional response, kick, or thrill behavior" within a level of the Affective Taxonomy, suggesting that this type of response could represent many different levels of affect from receiving to valuing (p. 131). Taking Krathwohl et al.'s (1964/1984) suggestion into account, the researcher chose to place overt emotional responses indicating enjoyment about accomplishments in the responding level because teachers associated these behaviors with students showing satisfaction in their accomplishments. The researcher considered teachers' dismissal of strong student reactions to a startling demonstration such as an explosion as indicating that those represented examples of selective attention, which Krathwohl et al. identified as receiving behavior. The teachers believed that the emotional response of students at the demonstration of an explosion was not as important as that associated with excitement they observed in students showing interest and satisfaction in accomplishment at the responding level.

Valuing. At the valuing level, Krathwohl, Bloom, and Masia (1964/1984) stated that student behavior showed recognition of the worth of a topic or activity. Behavior at this level frequently indicated a positive attitude toward a topic of instruction and, students showed increased and advanced interest in a topic and a more receptive attitude beyond basic satisfaction. As students became more interested in an activity or topic, they showed consistent commitment and motivation to work above and beyond requirements of the assignment or a

continued interest in the topic beyond the period of study and outside the classroom (Krathwohl et al., 1964/1984).

Six teachers reported behavior that the researcher classified as valuing. Teachers described students valuing a topic of instruction and developing a specialized interest in the topic. They related accounts of students showing continuing and advanced interest and commitment to an activity and demonstrating willingness to put in extra time and work beyond teachers' requirements. Teachers shared activities and topics of study that resulted in valuing behavior and examples of students demonstrating advanced interest in those activities.

David believed that his students demonstrated that they valued ecology when they developed a deeper understanding and showed advanced interest in ecological relationships. His students created water ecosystems in gallon jars using fish, algae, and other materials. In the following passage, David related how his students formed an understanding of the interconnection of organisms through the ecosystem activity. His students showed consistent commitment as they continued to collect data on their ecosystems beyond the time of study:

> I have students come in every day so interested to see if theirs [ecosystems] are still going. They have taken huge ownership of that. They can tell you everything as to why their ecosystem is still alive and why some have died. We're starting to see some cycling going on a little bit; everything from mold to algae. On a sunny day like this we will see bubbles being developed as oxygen is produced by the algae. That is their interest. We are not even studying it any more but that is the first thing they do every day is check on the ecosystems that are still alive. (David)

In this quotation, David described his students showing advanced interest in the topic, a valuing behavior. Further, as David's students continued to work on additional ecology activities and

developed an understanding of how organisms, including humans, "start working together" they developed appreciation of the topic and expressed an interest in the field:

> You know most kids don't like photosynthesis and respiration because it's so complex. But they started realizing about how we start working together and things outside work together [ecological relationships in an ecosystem]. We started to do some things outside [activities which were extensions of the ecosystem project] so of course the kids all of the sudden want to be an ecologist. 'I want to work outside. I want to work with these things.' (David)

In the previous passage, David explained that he believed his students had moved beyond showing a willingness to learn about the topic (responding level) to valuing the topic of photosynthesis because of their demonstrated understanding of the complex connections in the ecosystem. He also noted that they showed that they considered the topic to have worth by expressing an interest in the field of ecology.

In discussing valuing behavior, Krathwohl, Bloom, and Masia (1964/1984) explained that students exhibited recognition of the intrinsic worth of a topic by their questions or discussion of a topic. In such discussions, students demonstrated they had spent time reflecting on and speculating about a topic. When asked if she had observed student behavior showing that her students found value in their science lessons, Ellen responded:

> I've gotten them asking about things way beyond. I've gotten that from a couple of AP kids.… It's kind of whatever we are working on, except that it will usually be, 'Does this have any connection to this?'… They have read about something. 'Is this why this phenomenon happens?' I will get those questions, but it's not necessarily an 'I wish I

could learn more about this.' … They are trying to make connections [to more advanced topics]. (Ellen)

Ellen believed that making connections to advanced topics and asking advanced questions indicated students had spent time considering the topic beyond the bounds of the classroom study. In another example, Ellen explained that her students showed value in a topic that they were able to connect with their own experiences outside the classroom. In Ellen's description, students demonstrated that they valued the topic as they developed a deeper understanding of inertia:

> The topic where more people [students] have taken it and applied it outside the classroom is inertia. And they get really cranked up on the idea of inertia, like driving on snow and things like that.… It's kind of a self-assurance.… This is why it's important. This is what makes it valuable. (Ellen)

In the previous example, Ellen indicated that she believed that when her students made a connection between their science lessons and applications outside the classroom, it showed that they valued the topic because they could see how it applied to their lives. Ellen commented further on her students valuing physics as they dispelled misconceptions about inertia and recognized everyday applications:

> It was something they could see in their everyday lives. Or they could apply it to something they did. So you would see them move from just talking about it like it was a cool thing to know to, 'Since I know this happens here, then I know that this will probably happen in this other thing.' It's like once they were able to let go of the misconception, then they started connecting everything in a logical way and it was more

important to them that they could. I think they were really seeing the value of physics and how they could move from one concept to another. (Ellen)

Ellen believed that students talking about complex connections between physics concepts demonstrated that they valued the topic. Her statement about student comments changing from "talking about it like it was a cool thing to know" to explaining a physics concept described behavior that she believed represented valuing.

Teachers reported valuing in the form of commitment to working on an assignment about a topic that they valued. Teachers believed that as students developed an appreciation of a topic, they were willing to spend extra time and energy working beyond the requirements of the teacher. Eric described his students developing valuing behavior as they went beyond the assignment requirements in a dissection lab:

> On the dissection, there were only a few things they had to identify, just the basics, gills or lungs, how many legs, types of legs, what they were called. I tried to keep it simple as their first dissection and tried to get them to enjoy the exploration of it. When they first started they did just the basics. But somewhere, a switch changed, and half way into it they started going on line looking up the stuff. It was stuff I had not put in there, so I was not expecting them to know it. I didn't ask them what kind of terrain, what kind of prey, or how they go about acquiring that. One group made note of how the gills on the carapace in the front are kind of attached to the legs and how their internal system works. Little things that were of enough detail that you could tell that they did more than they needed to. (Eric)

Louis noted that his students demonstrated that they had internalized and cared about an issue by the quality of work that they put into an assignment. In the following passage, Louis

described groups of students creating products of high quality representing their position on an ecological issue:

> We did an ecology project where we did a week on an ecological issue.… They had to make some type of public service announcement. They could make some type of comic, or some type of video. There were some students who took it home and made videos beyond what I expected. We had a week in class to do it. They took it home and produced videos that were above and beyond what I expected. It [the time spent outside of class and quality of the videos] showed that they not only internalized the information but that they cared about the ecological issue. It somehow impacted them emotionally that they just presented projects that were worthy of YouTube commercials. (Louis)

In the previous comment, Louis explained that by making videos that were "above and beyond" what he expected about their positions on an issue, students demonstrated that they valued the issue.

Sarah described her students showing they valued a topic by demonstrating continued interest, bringing her articles they found or pictures they created:

> I'll get the students that will find a topic that they are really interested in. And I'll wind up with some coming in and giving me a picture that they've drawn or coming in and asking about something later that they saw in the news. (Sarah)

Krathwohl, Bloom, and Masia (1964/1984) described valuing behavior as demonstrating "drive and perseverance," as well as satisfying a need (p. 150). Ellen observed this characteristic as she noted students' drive to complete challenging assignments outside of class time. Ellen described this behavior as students worked on physics problems:

> With AP [Physics] I have some kids spend a significant amount of time outside of class doing homework. And one of the interesting things has been watching these kids and helping them learn how to navigate. And the idea that if you spent four hours on one homework problem, that was probably too much, and you probably should have walked away after a half hour, cleared your brain, and come back to it later.… I have some kids that got stuck on something and they were just banging their head against it until they got it even if it's six months from now. (Ellen)

In this comment, Ellen noted that her students showed a drive to satisfy their need for understanding and completing complex physics problems. She indicated that she worked with her students to help them use that drive in a more efficient manner.

Beliefs. Behavior in the valuing level may include students expressing beliefs (Krathwohl, Bloom, & Masia, 1964/1984). The individual feels strongly about and personally identifies with her beliefs and values, expressing loyalty and conviction toward a belief. In describing behavior representing beliefs, two teachers reported that students discussed their beliefs in relation to owning guns. Many of the students in their classes owned guns, and at the time of the study, incidents involving guns were prominent in the national news. Discussions about gun control occurred in Jane's classrooms. Jane commented on students in her classes displaying a conviction about *their right* to own guns:

> They are very talkative about guns and gun control. Everything is very black and white.… I have kids that talked a lot about gun control this past year.… I usually don't give my opinion, but I would let them talk about gun control. I would point out reasonable—try to bring them towards a more centrist approach. At a certain level everything's black and white. But the more educated you get the grayer everything

> becomes. 'I understand where all you guys are coming from, and I want to make sure you understand bringing a gun to school is against our school policies.'… It's hard for a lot of kids to understand.… They don't understand the ramifications of that. Guns came up a lot because of some emergencies and lock downs in the building. So that was why I went ahead and let them talk about things. It is a value for them. (Jane)

In the previous account, Jane characterized her students' beliefs in gun ownership as a value, echoing Krathwohl, Bloom, and Masia's (1964/1984) descriptions of valuing behavior including beliefs. Other teachers in the case study also described students' beliefs, particularly involving religion. However, in those descriptions, students compared their religious beliefs to science topics such as evolution, and the accounts were therefore identified as organization level behavior. Organization level behavior characterized by comparison of beliefs is discussed in the next section.

Organization. Krathwohl, Bloom, and Masia (1964/1984) described the organization level as comparing internalized values or beliefs with new values and arranging those values into a value system. Krathwohl et al. (1964/1984) indicated that student behavior at the organization level showed consideration and comparative judgment. Students were able to consider values associated with a topic and compare those values to their own beliefs and values. As students compared values they organized values into a system by determining relationships between values and identifying what they considered to be the principal values. Through this process, they created personal value systems.

Five teachers described behavior that the researcher identified as organization level based on reports that students compared values they associated with topics of learning to their personal beliefs and values. Examples of behavior representing organization appeared during the study of

topics that some students perceived as controversial such as evolution, geological time, and the origin of the universe. Teachers described students demonstrating organization as they introduced and examined scientific evidence and the unifying theories associated with topics, such as evolution. While all eight teachers reported addressing perceived controversial topics in their classes, only five teachers reported student behavior that the researcher classified as organization. Teachers' examples of organization behavior indicated that students worked through perceived conflicts between their religious beliefs and the theory of evolution. As students learned more information about the facts of evolution, they resisted the topic less and became more willing to listen. Students' willingness to listen to information about the theory of evolution did not indicate acceptance of the theory. However it did indicate that students found a place for it within their belief system, suggesting organization behavior.

Teachers reported being careful in their approach to evolution and were mindful of students' beliefs as they introduced the topic. David shared his account of students demonstrating organization behavior as they compared their personal beliefs with the theory of evolution. Initially his students expressed a conflict between their beliefs and evolution:

> I've had kids look at my syllabus, parents send me notes, kids say, 'I want to be excused from your class.'… I tell them we don't know what really happened, none of us were here. That usually helps them be more willing to look at it. (David)

As David's students compared their religious beliefs with the theory of evolution, they became less resistant and more willing to learn about evolution. David described his students' change in attitude as they examined the facts about evolution:

> I would say they were firm on what they believed. But it has also been great to watch them develop that skill of listening to other opinions, other ideas, scientific theory,

> looking at it from another perspective.… People have this mindset that evolution is just the Big Bang theory. There is so much more than that. I have kids that want to ignore part of it and love other parts of it [evolution] just like other subjects. And all we ask of them is just look at what we know.… A lot of them before they learn anything say that it [evolution] conflicts with their religion. But after they have learned about it, don't have an issue with it. (David)

David believed that his students demonstrated a change in their attitude toward evolution based on their questions, group interaction, and body language:

> They are more willing to ask questions than they were at first.… The next thing you know they are interacting and sharing ideas in a group. And over time as we talk about it, they relax and sit more open, make eye contact and ask questions. (David)

In David's preceding accounts, the researcher identified the students' affective behavior as organization level because students expressed conflicts with their beliefs followed by a change in attitude over time. Initially, David's students resisted discussing the topic of evolution. Over time they demonstrated a willingness to ask questions. David's students' willingness to ask questions and listen to facts about evolution did not mean that they accepted or agreed with evolutionary theory. They indicated that evolution conflicted with their beliefs and were not willing to discuss the topic. However, their eventual openness to discussion, as reported by David, suggested that they had created a place for evolution within their value system.

Greg also described his students becoming more open to evolution. He discussed their initial ideas on evolution and how he could see the change in their attitudes as they learned about antibiotic resistance in bacteria:

> They always bring up that they think [the theory of evolution is] man evolved from monkeys. I have to explain to them that that is not exactly what we are talking about here. [I tell them] 'I don't think in evolutionary theory that anyone ever really said or thought that.' (Greg)

Greg described his students considering the facts about evolution, and how he could see in their facial expressions that they were thinking and developing an understanding of evolutionary theory:

> I would talk to them about gradual change, give them examples of bacteria, how bacteria are becoming resistant to antibiotics.… I think it would start to click when I would bring up examples, when we talked about MRSA, and how things evolved. They would evolve from being killed by penicillin into a resistant bug, a better bug. I think it started to click with them a little bit. Then they would talk about how evolution works. If you could put a physical face on that, if you could show them MRSA and how that is resistant to drugs, and compare things to real life that they could see, that made a big difference. … I could see them thinking, well maybe there are certain parts that are true and certain that aren't. I didn't have to say much. You can kind of see it on their faces. You could see them start thinking about it. (Greg)

Sarah was also careful in her approach to the study of evolutionary theory and the connection with her students' beliefs. When asked about working with students' beliefs about evolutionary theory in her science classes, she explained, "The way I leave things open, the way I try and draw things out of them is to try and get them to think about it [the theory of evolution], not make them believe or accept it [evolution]." In this statement Sarah indicated that she helped her students examine the topic and make a comparison with their belief system. Rather than

change their beliefs about evolution, she encouraged them to think about the evidence they had learned in the classroom:

> My overall goal for science isn't for them to sit there and spout facts back at me, but if they read an article, that they think about it and try and get some of that higher level learning into that.… That's what I'm trying to do is build all those lower levels, all those steps for them. So that when they get out, when they see something they will go, 'Wait a minute; I can relate that back to here,' and it will make sense to them. (Sarah)

Ellen noted that age level seemed to play a part in students' ability to make comparisons and develop organization level judgments. She observed that her younger students in Earth Science classes were not able to establish a place for science within their religious values as readily as the older students in Advanced Placement (AP) Physics:

> It seems, drawing comparisons between the kids that I've taught in AP Physics and Earth Science, it's like the higher level you are, the easier it is to accept or be OK with the dichotomy [separation between religion and science] that you can explain. The lower [class level] you are the more upset you are going to be.… In AP Physics, they would at least be willing to entertain that idea. They would at least be willing to consider it before they rejected it. (Ellen)

In this example Ellen reported her observations of students comparing their religious beliefs to theories of geological time and the origin of the universe. In her experience the older students in her AP classes were more willing to examine the evidence and make the comparisons that were needed for organization level behavior. This distinction indicated that Ellen recognized relative internalization of affect as she pointed out the difference between the behavior of the younger and older students.

Jeff reported his students expressed their religious beliefs during the study of geological time. He noticed his students revealed conflict between their religious beliefs and science theories:

> I'm not certain that they are real comfortable with that [comparing science and religion]. Their body language, them looking at each other, a little hesitant to address it, there is a struggle going on. But I don't see them willing to resolve it. We did a little bit of that [comparing science topics with religious beliefs], but they did not change their positions. (Jeff)

In this description, Jeff believed that his students were reflecting on their own internal value systems but were not willing to compare those values with science topics. This behavior was similar to that reported by Ellen in her ninth grade Earth Science students. The researcher believed that Jeff's students were demonstrating response at the valuing level in that they expressed religious values, but did not advance into the organization level and compare the topic of study with their own values.

These accounts indicated teachers recognized student concerns about their values in relation to science and managed student affect during the study of controversial topics. Additional insight into how teachers worked with student affect during the study of controversial topics is included in Emergent Themes under *Management of Affect with Perceived Controversial Science Topics*.

Characterization. Krathwohl, Bloom, and Masia (1964/1984) stated that at the characterization level, the individual developed a hierarchy of values and was consistently controlled by that value system. Two aspects of behavior demonstrated characterization: (a) a *constant orientation* or predisposition that guided the individual's actions and (b) a *consistent*

value system which guided the individual's conduct. Students showed *constant orientation* guiding their actions by demonstrating the *ability to consider issues and problems objectively*. Students with a *consistent value system* showed a consistent code of behavior, *exhibiting kindness, respect, and humility in their actions toward others*.

Krathwohl, Bloom, and Masia (1964/1984) believed that characterization behavior was slow to develop. He suggested that student behavior at this level was difficult to observe within a semester of study. Consistent with Krathwohl et al.'s (1964/1984) findings, only three of the eight teachers described student behavior that the researcher associated with characterization. While teachers had observed some examples of students beginning to show objectivity at the organization level, none of the teachers described student behavior that the researcher classified as constant orientation. Three of the teachers described student behavior that the researcher found to suggest a consistent value system.

When asked if he had observed consistent behavior that he considered evidence of following a set of values, Greg described behavior representing his students' work ethic:

> They were intent on learning. And I think a lot of that was due to the values they learned at home. They were all business. When they came into school they were going to learn. It wasn't just on a belief or a value; it was about facts that we had been learning. The parents were asking a lot of questions and the students were very intense.
>
> When we did assignments I would tell them not to copy but to get into your groups and discuss the topic, then write their answers. They would make sure that everything was done just right because of the value system they brought. They didn't want any part of cheating or for anyone to think they were cheating. (Greg)

Two of the teachers commented on their students exhibiting consistent value systems in their respect, kindness, and concern for others. Ellen described a student who she believed exhibited a consistent value system in her maturity and concern for others:

> She is extremely conscientious and extremely responsible. I would say of all the teens here … she probably has one of the strongest characters…. It's not that she is the smartest in the class. It's that she approaches problems with the best of her ability. And I get the impression from other teachers that this is her. (Ellen).

Ellen's comment that other teachers had noticed this student's behavior contributed to her belief that this student's behavior was consistent. Ellen continued her description of the student's character: "She is very kind hearted. She doesn't want to hurt anyone or do things that upset other people.… She is just very conscientious. She is one that I would point to." In Ellen's account the student's behavior stood out from that of the other students. When asked about the consistency of her character, Ellen noted that her conscientious behavior translated to her classwork:

> At the beginning of the year, I was trying to figure out what a good homework load was for the AP classes. Even if I gave them an outrageous assignment she would do everything that she possibly could to have it done and complete.… She would do whatever she could. (Ellen)

Ellen's account of this student exhibiting characterization level behavior was significant in that her reports were from multiple situations and sources: attitude towards school, quality of classwork, actions toward other students, and the impressions and observations from other teachers.

When asked about students exhibiting consistent value systems, Sarah commented that she had observed this behavior in groups of her students noting that they demonstrated caring and concern for others:

> I definitely will see that concern for others. And it can be toward that more special needs kid in the class. I have [observed concern] with kids who have [been sick], where a kid is not there. And the other students will ask, 'Are they OK today?' (Sarah)

In this account Sarah focused on the class as a whole and did not consider one student to stand out from the others in this behavior. Her statement about students inquiring after the welfare of their peers indicated that her students were concerned about the well being of their fellow students.

It is difficult for the researcher to determine whether these accounts were truly characterization behavior because there were only three examples and the researcher did not observe this type of behavior during classroom visits. The lack of teacher reports of consistent value systems guiding behavior could be attributed to the difficulty in observing this type of behavior in a class where the goal is academic progress and science learning. Further, teachers themselves may have believed that their students were not capable of this level of affective behavior. Eric's comments on his students' moral development were revealing:

> A lot of the time they would do what they thought was appropriate whether it was right or wrong. I would say [students had] a value system, but it was their own. Not necessarily what you or I would call a set of morals. It was their own set of morals.… They had their own integrity. If you had a rule in place that they didn't think was appropriate, they wouldn't follow that rule. They had their own way of interpreting that. (Eric)

When asked about observing a consistent high level of concern for others in his students, Eric commented:

> I've watched a student be respectful in the classroom, but be disrespectful to his parents, so it's kind of a situational thing. It depends on the situation. It doesn't mean they don't have values; they just change with the situation. (Eric)

Eric's comments suggested that he did not see consistent character or developed values in his students. Rather, he saw enough of their behavior to recognize that their value systems were still developing. The few reports of characterization behavior observations by teachers was supported by Krathwohl, Bloom, and Masia's (1964/1984) conclusion that characterization behavior may not be developed until years after formal education is completed.

Teachers' Understanding of Student Affect

Beyond providing examples of affective behavior, teachers in the study revealed an understanding of the nature of student affect in their reports. In analyzing their reports of levels of affect, the researcher found that they recognized the relative internalization or levels of student affective responses in that they understood that different types of behaviors represented different levels of affect. They also revealed preferences for development of responding behavior because they recognized that at this level, the student had moved beyond compliance to demonstration of interest. In many of their reports, teachers described affect in association with their instructional activities. The researcher found that teachers recognized that affect changed during the course of a unit of instruction, and they associated that change with their instructional activities.

Emergent Themes

In answering research question 2, *How do science teachers work with student affective responses, as identified by Krathwohl's Affective Taxonomy, in teaching science?* and question 3, *What interactions do science teachers report are present in the classroom when they work with student affective responses as identified by Krathwohl's Affective Taxonomy?*, the researcher sought to learn how teachers worked with student affect in the classroom and what interactions occurred as a result. The researcher considered working with affect to include identifying, developing and using student affective responses. It is important to note that working with affect rather than provoking affect was of interest to the researcher. In working with student affect, the teachers used classroom interactions and activities to provide students with opportunities to show their natural behavioral responses. Teachers observed those behavioral responses in the classroom to understand students' attitudes toward science learning. Provoking affect implied that teachers created situations to cause affect that might not have occurred in normal learning situations in the classroom.

The researcher identified two affective levels in which teachers reported the most information about behavioral responses: receiving and responding. The researcher noted that at these levels teachers often shared descriptions of instructional activities, such as reading, note taking, or projects along with descriptions of student behavior. In many of the accounts, teachers described student affect within the context of an instructional activity that they had created for the purpose of developing interest.

Taking into account teachers' tendency to describe instructional activities when reporting student affect, the researcher began the process of analyzing data for emergent themes. In examining these teachers' accounts, the researcher noted that many of the activities that teachers described in their reports of affect created opportunities for interaction, some between the

students and the teacher and some among the students. The researcher's classroom observations supported this finding. The researcher recognized an important theme representing teachers working with student affect and the resulting interactions. The researcher labeled this overarching theme *teachers working with student affect through interaction.* The researcher found examples of teachers initiating, developing, and responding to student affect, and these data indicated that interaction through collaboration and conversation was a significant mechanism for working with student affect. In analyzing these data within the overarching theme of *teachers working with student affect though interaction*, the researcher identified five emergent themes:

1. Use of Affect: Teachers used affect to gauge student attitudes and improve instruction.
2. Management of Affect: Teachers managed student affect to work with students during the study of perceived controversial science topics.
3. Collaboration: Teachers used collaboration during classroom activities to develop responding behavior.
4. Conversation: Teachers used conversation in the classroom to improve student attitude.
5. Affective Progression: Teachers helped students move through affective levels from receiving into responding and valuing behaviors.

The emergent themes identified within the reports of each teacher are summarized in Table 4.3.

Table 4.3 Emergent Themes by Teacher

	Emergent Themes						
					Affective Progression		
Teacher Pseudo-nym	Use of Affect	Management of Affect with Controversial Topics	Collaboration	Conversation	Receiving to Responding	Frustration Response	Responding to Valuing
David	√	√	√	√	√	√	√
Ellen	√	√	√	√	√	√	√
Eric	√	√	√		√		√
Greg	√	√	√	√	√	√	
Jane	√		√		√	√	√
Jeff	√	√	√	√	√	√	
Louis	√	√	√	√	√		√
Sarah	√	√	√	√	√		

Use of Affect

In analyzing teacher interviews, the researcher found that these science teachers were familiar and comfortable in working with student affect. All eight teachers reported that they used student affect to gauge student attitudes and improve instructional practices. Teachers recognized student affect and they revealed a preference for types of student reactions. For example, when asked if he used student affect in the classroom, Louis responded:

> Yes, I play to it.… I think the [affective response] that satisfies me the most would be joy. That lets me know that they are learning.… Like when we do the bird beak lab, it's sheer joy. They enjoy learning that way. (Louis)

In this statement, Louis's use of the expression "I play to it," meant his actions were intended to bring out student affective behavior. Not only did Louis confirm that he created opportunities

for student affect in the classroom by playing to it, but also in identifying joy as his favorite affective response, he indicated that he recognized other types of affective responses during the learning process. He also revealed that he used affect as an indicator that students were learning.

In using affect to gauge student interest, teachers watched for student affect in the form of facial expressions, body language, and responses to lessons and activities. Jane explained that she watched for facial expressions but wanted to see responses that indicated student interest:

> It might be just facial expressions, but I am trying to get a little bit more reaction. I would like to see people interested or getting it. I would like to pick topics that they are interested in, that they can think about. I would like to see that they are making a connection. (Jane)

In this statement, Jane suggested that facial expressions let her know that her students were interested in a topic. She selected topics that not only introduced and developed science concepts but created interest, stimulated thought, and developed connections.

Sarah watched for student facial expressions as an indicator of engagement and interest. She believed that interest supported retention of knowledge:

> If they are just sitting there deadpan [expressionless], they are not engaged; they are not interested. They are not going to think of this when they leave the room. If they are interested; if they are responding, then I know that it's in their heads, and when they leave this room, it will still be in their heads. (Sarah)

In the preceding quotation Sarah observed student facial expressions to gauge student interest, and she equated interest with responding. This statement was notable in that Sarah's association of interest with responding was consistent with Krathwohl's Affective Taxonomy. Further, Sarah connected student interest in learning a topic with retaining it beyond the classroom. Other

teachers also used affect as an indicator of student interest. Ellen commented on using student response and interest to let her know that students were learning:

> One of the things that I hate as a classroom teacher is the feeling that I am talking at them and don't have any feedback. I've got to have feedback. I've got to have response, I have to have interaction, and I would rather have a classroom that is verging on out-of-control, that people are talking and communicating, than one that is incredibly quiet and well behaved. Because if they are well behaved they are probably not thinking, not interested. (Ellen)

In this statement, Ellen shared that she used student interest and response as feedback. She described the need for interaction between students, suggesting that it indicated both interest and thinking.

When asked how he used affect in the classroom, Jeff described watching for openness to learning about a topic and negative affect that interfered with students being receptive to a topic. He considered student participation to be a type of affective behavior that he watched for and encouraged:

> I primarily try to determine if the students are open to the material and working at it. I try to key in on which aspect of a problem triggers a negative response so that it can be addressed. In discussions, I look for who is and is not participating so that I can bring all of the students into the discussion. (Jeff)

In this statement Jeff revealed that he watched for student affect. His phrase "open to the material and working at it" described student behavior that the researcher identified as responding level behavior. This statement indicated that Jeff recognized a level of student behavior and considered it desirable for student learning.

Teachers reported using affect to judge student comfort levels and classroom climate. They also used affect as an indicator of their success as a teacher. Sarah believed it was important to make students feel welcome in the classroom. She explained that developing positive affect in the classroom improved her students' attitudes toward school. She also used student affect to gauge her teaching success:

> One of the things I see is less tardies, less skipping, because the kids enjoy being here, and that's what I want. I want them to come in and feel welcome in the room. I want them to come in and feel like today we are going to get something cool to learn and not be afraid of it. And if I can do that I feel very successful as a teacher. I've even had students who … when they found me on their schedule come back and say 'I'm so happy I'm going to have you again.'…They liked being here. They weren't skipping my class. So I feel I'm successful as a teacher. They wanted to come. They may not have gotten an A or B, but they are in class, they are engaged or involved. Some will catch me later and tell me what they have found in the news, and we will talk about it. So that's my measure of things gone well. (Sarah)

In this statement, Sarah indicated that she associated student attitudes in the classroom with her success as a teacher. If students felt welcome or were interested and engaged, she believed she was successful as a teacher.

Greg reported that awareness and recognition of student affect allowed him to detect and try to improve student attitudes:

> If I can figure out their feelings at the beginning of the day—with the ninth grade, half of them are up, half of them are down and some of them are off the wall—if I can get a handle on it before class, then I kind of know how to approach the class for the day. But

> sometimes they really come in mouthy and negative. And you can be as positive as you want and really get going with a positive attitude. And something we are going to do today, they can shut down really fast.…The more I can pick up on what they are feeling and their attitude is for the day, the better it is when I go around and help them in small groups and everything. (Greg)

These reports suggested that these teachers used affect as an important part of the instructional process. They used student behavioral responses to gauge student interest. They also used affect to evaluate the progress of learning and success of the lesson. Teachers considered student affect to be a form of feedback to improve their instruction. In the preceding accounts the researcher presented reports of teachers using affect as a form of feedback. In the following section, the researcher explored how teachers managed affect as a part of the instructional process.

Management of Affect with Perceived Controversial Science Topics

In examining teachers' accounts of their experiences teaching topics that some students perceived as controversial such as evolution, geological time, and the origin of the universe, the researcher found that teachers observed student affective responses during the study of these topics. The researcher was particularly interested in teachers' experiences with lessons on these topics because she assumed that religious beliefs would surface. The researcher was interested in teachers' responses to their students' expressions of these beliefs because of the practices learned in their science methods and laboratory techniques classes. In those classes teachers learned to allow students to discuss beliefs and values in the study of evolution. The researcher assumed that teachers would have examples of negative affective responses during lessons on controversial topics due to conflict with some students' religious beliefs. All eight teachers

indicated that they had taught lessons involving evolution, geological time, or the origin of the universe in their classrooms, and all had experienced some students expressing religious beliefs during the study of those topics. For example, Jeff described his students bringing religious beliefs into a discussion of plate tectonics:

> They have very conservative views for the most part. Most recently, we watched a video on plate tectonics—the formation of the earth. After the video, I tried to get a discussion on where did the heat come from that's driving plate tectonics, and how did the earth form. And the discussion came down to Jesus created the earth. It was one student and the rest went along, and that kind of shut it down. (Jeff)

Jeff believed that concerns about conflicts between science and religious beliefs interfered with students' abilities to learn about the topic. He noted that students' affective reactions to controversial topics stopped the classroom discussion.

Ellen described her students challenging science explanations on the origins of the universe and geological formations with their religious beliefs:

> I had a picture of a U shaped valley on a test last year, and I asked what would cause the valley to be U shaped. And I got an answer that God wanted it to be this shape.… Last year any time someone brought up God or creation or anything like that they were very firm. It was like a flat out God created the universe. (Ellen)

In her account, Ellen noted that her students brought up their religious beliefs when asked to explain geological formations. Rather than explaining what they had learned in their science class, they expressed their religious views on the topic.

Seven of the eight teachers' accounts of students' reactions to science and religion in the classroom indicated that they were aware of their students' concerns about perceived

controversial topics, and they responded to those concerns by creating opportunities for students to develop openness to learning about these topics. This led the researcher to identify the subtheme of *teachers managing affect in the study of perceived controversial topics*. By managing affect, the researcher meant responding to student affect and guiding students in the process of working through their concerns about the study of controversial topics. In the earlier section on Organization, the researcher discussed teachers' reports of student behavior during the study of controversial topics. In this section, the researcher focused on the teachers' actions and how teachers managed student affect and helped students to be comfortable in learning about controversial topics. Seven of the teachers reported that they managed affective behavior in the study of perceived controversial topics by (a) being alert to student behavioral responses showing student concern, (b) responding to student affect by calmly talking about the science of the topic, and (c) providing facts and information about controversial topics.

In managing student affect, teachers indicated that they were alert to behavioral responses that showed students were concerned about controversial topics. They reported watching for statements, facial expressions, and body language as indicators of student concerns. They described student body language changing from closed to open posture as students developed a more accurate understanding of evolutionary theory and became more comfortable with the lesson. Louis observed his students' body language as they became more comfortable with the topic of evolution:

> Their arms go from this to more open [showing crossed arms to open arms] when we talk about human evolution and how it is a big misconception that monkeys evolved into humans. They think that a chimp stood upright and was a human the next day. That is a lot of their view of evolution. When I dispel that misconception, then they are much more

> open in body language. Those that are resistant at first, when they see that what they have been taught about chimps evolving into humans isn't accurate, then they are much more open to learn about it. (Louis)

In this statement, Louis indicated that he watched for student body language to indicate student attitude toward the topic of evolution. He observed changes in body language as students learned accurate information about evolutionary theory. David also described observing student body language as his students learned more information about evolution:

> I do an introductory activity on evolution. And some [students] have their arms crossed and won't look at me or look disinterested.… And over time as they learn about it, they relax and sit more open, make eye contact, and ask questions. (David)

In the preceding statement, David indicated that student body language showed that changes in attitude occurred as he provided accurate information on evolution.

In addition to being alert to student body language, teachers indicated that they managed students' concerns about religious beliefs in the study of controversial topics by calmly talking about the science of the topics. David noted that talking to students about the science of evolution helped students overcome their concerns:

> We just talk about it. You know evolution is a natural process and we're just going to learn about it. We're not going to bring up God and all that. We are going to talk about what naturally happened and look at the known facts.… They always worry. I tell them we don't know what really happened. None of us were here. That usually helps them be more willing to look at it. (David)

In this statement, David explained that talking to students about science as a way of explaining natural processes aided students in becoming more open to learning about evolution.

Louis explained that he encouraged students to compare their beliefs with their understanding of evolution:

> We start the unit off with a discussion of their understanding of evolution. They write any explanations of the origin of the species that they are aware of. The next day, we talk about it. We make a list of reasons for learning and reasons against learning about evolution. Of course religion comes up. I show a web site that has ten creation stories from different cultures. I share a few of them with the class. The students are surprised. We will talk about how religion influences their beliefs on evolution. We talk about how in science class we will learn about the science explanation about how things came to be. (Louis)

Jeff also talked to students and addressed their concerns about conflicts between their religious beliefs and science. He explained the need to develop an accurate understanding of science and the value of science for making predictions:

> I just talk to them, 'This is what the science says, and this is what I want you to understand. And what you do with it is up to you. I don't require that you believe in it, but you do need to at least understand it.' And I try to get across that science is valued for making predictions in our lives, improving our lives… and I will leave it there. (Jeff)

Similarly, Ellen addressed the conflict by discussing how science and religion provided answers in different areas:

> We have had discussions about religion and theology.… One of the things we ended up talking about was that religion and science answered different questions. And if you look back in history, any time that it seems like there has been a major disagreement between science and religion, if you wait a couple of hundred years, it gets resolved. (Ellen)

Eric worked to help his students get past their concerns about conflicts with their religious values. He explained that the information that his students learned about evolution could help them in future decisions:

> I brought it up in a way that wouldn't make them think I was trying to preach to them, and I worded it very carefully so they didn't think I was trying to give them values. I'm giving them information. I'm giving them facts. I worded it very carefully so I would have people thinking—I was not trying to put their religion in question. I was trying to convey information that they may find pertinent to a decision they might make in the future. (Eric)

These preceding accounts by teachers indicated that development of an accurate understanding of the facts supporting evolution helped students become more comfortable with the topic. As noted by David, "I tell them to look at it in terms of the facts we know. A lot of it is just a theory. Most of them are open to that."

In the following passage, Louis described his experience with managing affect in students showing concern about the study of evolution. Louis illustrated the process of managing student affect by (a) being alert to student behavioral responses showing concern, (b) responding to student affective behavior by calmly talking about the science of evolution, and (c) providing accurate facts and information about evolution. Louis initially noted his students' behavior:

> I could tell from the things they said or their body language or the facial expression that, 'This guy is going to make me learn about evolution. He's going to take my religion away from me.' (Louis)

Louis calmly talked to his students about the science of evolution as a tool for understanding the natural world:

> I talk about using tools from the tool belt. This is just another tool. I get out a container and I put in scissors and rulers and crayons and markers. I say, 'OK this is your knowledge.' I say, 'If we learn about evolution, I'm just putting more things into your knowledge bucket. I'm just putting things into your bucket.' (Louis)

In the preceding statement, Louis described how he responded to students showing body language that indicated negative affect toward the topic of evolution by calmly talking to them about the use of the science of evolution as a tool for understanding and gaining knowledge. Following that, rather than challenging their religious beliefs, he provided facts and relevant information about evolution to allow students to maintain their belief system *and* consider evolution to be valuable knowledge:

> What I do is right away hit them with applications. The second day of class we watch a video about HIV and doctors talking about how they wouldn't be able to treat patients with HIV if they didn't understand how viruses evolve.… *I want them to see that regardless of what they believe that knowledge is what is important.* I do a ton of applications with antibiotics at this point. We do case studies with antibiotic resistance.… I think evolution is one of those topics that it's hard to get past their beliefs. I think I'm good at teaching it. If they can tell you why they have to take antibiotics till they are gone, if they are going to be a doctor why it's important, or to a parent that has a sick child, then I have accomplished what I want them to learn. (Louis)

Louis revealed that he believed that he had developed effective techniques for managing student affect associated with the study of evolutionary theory. He considered it necessary to address student beliefs. His goal was to help his students develop an understanding of the application of evolution to medical problems.

Sarah explained that use of the term evolution produced affective responses indicating students were concerned about the relationship of evolution to their beliefs. To manage student affect, she introduced evolution to her classes through natural selection:

> The way I introduce evolution is I do everything natural selection. So they don't actually hear the word evolution until the end of day two of my talking about natural selection, because by then they understand what it really is. If you start with 'Today were going to talk about evolution,' I've had kids who go, 'Well I don't believe in evolution.' But If I talk about natural selection and talk about how animals become more adapted to their situation, and then I introduce Darwin they say, 'Oh is that what it's about?' The buzzword [evolution or Darwin] can't be there initially, because that's all they are taught, that the buzzword is bad, not why. So if I can go around that [avoid the use of Darwin's name initially] and explain first, then I can get around that. (Sarah)

In the preceding passage, Sarah explained that she believed some students responded to terms such as evolution and Darwin in a negative way and that she needed to help them get past their concerns. She managed her students' negative responses to evolution by talking about processes such as natural selection that they could understand and then explained how those processes were a part of evolutionary theory. In this way, she avoided students' initial concerns about their beliefs and created knowledge that supported their ability to achieve organization level affect.

These accounts indicated that not only were these teachers able to use affective behavior, but that they were able to manage it in their classrooms. Their ability to respond to student affect allowed them to assist students in overcoming their discomfort and learn about topics that they felt were in conflict with their religious values. Teachers' descriptions indicated that discussions and conversations were important in managing affect. In the next section, the researcher

continued discussion of teachers' use of interactions in working with affect in the science classroom.

Interactions for Development of Affect

The researcher examined interactions in the classroom reported by teachers as conversations, discussions, and student collaborations on lesson activities. In analyzing interactions, the researcher found that teachers' actions and the resulting classroom interactions in which affect emerged were interconnected in that *teachers used interactions in the classroom to work with student affect*. Interactions were the mechanism used by teachers to bring out, develop, and manage student affect in the classroom.

As the researcher examined teachers' reports of interactions two areas emerged as key to working with student affect, *collaboration* and *conversation*. Teachers described using collaboration to develop student response and interest in a topic. Similarly conversations were used to improve student attitude by developing students' trust and improving their confidence in science learning. There was significant overlap in use of the two practices in that teachers also described collaboration as building trust and confidence and conversation as creating interest. In the following sections, the researcher presents teachers' descriptions of collaborations and conversations and the resulting behavioral responses.

Collaboration for Development of Responding

As noted in the section on responding, these teachers considered it important that students move from compliance to willingness to respond. All eight of the teachers said that collaborative groups encouraged students to support each other and progress into the responding level of affect. Teachers gave examples of students beginning a topic of study by working individually on the introductory activities. In these initial knowledge-building activities, students

demonstrated compliance. As teachers assigned projects requiring collaboration, they reported observing examples of positive affective responses, particularly enjoyment and satisfaction in accomplishment as students worked together in collaborative groups, indicating that students had progressed to responding level behavior. Teachers reported that they worked to develop effective collaboration among their students, creating instructional activities to encourage students to work together.

All eight teachers reported that as students worked in collaborative groups most were able to transition from compliance to responding level behavior. Four teachers suggested that collaborative group activities and projects allowed students to support and encourage each other as they worked on assignments. Greg described his students supporting each other in collaborative groups:

> They would push each other. They worked in teams and they really like to push each other. They would get into their little groups and they would flat just start on their research papers. They motivated each other. Some of the groups just pushed each other pretty hard. (Greg)

Jane commented on collaborative groups helping students progress from receiving to responding level behavior. When asked what she thought was responsible for the transition from compliance to willingness to work without pressure from the teacher, Jane responded, "I think it was mostly working together as a group. Once they got going, it just seemed to be easier for them to keep going and work together as a group. The group just seemed to keep them going."

Jeff also reported using collaboration to help his students to move from the receiving level into responding:

> I took a hard look at how they were working, what their grades were.…I was doing a lot of lecturing, and I started putting it more on them. I required that they work together in groups. They have to answer questions together on their own without my lecture. In the collaboration they enjoy what they are doing. When they get to the point every once in a while they look at something and realize that they really have got a grip on it and realize they understand it, they will get that satisfaction, that response then. (Jeff)

When asked about students' transitions from compliance to responding behavior, Louis described his students' attitudes during study of ecology as he changed the classroom activity from individual research to working in groups of three or four students on a project requiring that they create a presentation:

> The first half [of the unit] was just research [on water conservation]. I had articles for them to read. In the beginning that's what they did. We just read about that issue. They didn't want to read the articles but they knew they had to do it. (Louis)

When asked what he believed contributed to his students moving from compliance to responding, Louis indicated that working in groups facilitated the transition. He described his students' transition to responding behavior as they began their group activities. Louis portrayed his students' willingness and excitement at working in collaborative groups:

> It was when they started working in groups with the technology.…The ones [groups] that made a comic or an animation, they just got a kick out of being able to do that.… Those [groups] that wanted to do the video—I don't know how to say it—they just attacked production of the video, coming up with a script. Some of them went around the building interviewing people.… I gave them a lot of freedom. 'Go interview someone in another

> class.' I had students go to the atrium. I just left them the whole hour and they continued on the work. (Louis)

In the preceding passages, Louis described his students' progression from receiving to responding as they transitioned from researching a topic individually to collaborating on a presentation about the topic. His students initially were compliant but reluctant to do the individual research. But when they started working together he used "attacked" to describe their behavior, suggesting a strong willingness to do the work without prompting from the teacher. He noted that his students continued to work on the assignment outside the classroom without supervision.

Collaboration was not a simple matter of assigning students to groups. Teachers described how they worked to develop effective collaboration among their students. Jane saw students develop appreciation for the lesson after she improved her instructions for the collaborative groups:

> At first they just sat around in their groups and talked and maybe came up with bullets. The first year we did this, I just got one or two decent projects. I gave them redo opportunities [she allowed students to redo their projects for a better grade], but they weren't interested. But the next year, I came up with a checklist that seemed to help. That year all were satisfactory. I think that is when I could see that they appreciated the assignment. (Jane)

Jeff worked to develop effective group activities when traditional methods of requiring students to work independently were not successful. He noted that students resisted working in groups at first but showed satisfaction as they became more comfortable with collaboration:

> They have a post assignment that has more open-ended questions.… The open-ended assignments are all collaborative. They all work together. I had to push them a little bit when we first got started. Some of them wanted to work by themselves. But I keep encouraging them to work with each other. And that is where I am seeing more enjoyment, more satisfaction in their work. (Jeff)

Jeff explained that he had to create an effective lesson activity in order for the students to collaborate successfully:

> One of the changes is that they have to use these specific terms to describe explain what's going on, trying to get them to incorporate a real specific vocabulary to describe what happened rather than relying on the shortest answer they can come up with. So I have them use these terms for the description. That's fairly new. They work on their explanation in their small groups and hang onto it for our large group discussion. So before they turn it into me, we can go over it. We discuss it in the large group, so the large group pushes the small groups and encourages those who aren't sure of their descriptions and helps them get the material. Then once they have that large group discussion, they are more confident in their answers. (Jeff)

When asked how he knew that they had developed confidence, Jeff responded:

> They aren't just sitting around. They talk to each other. They look happy and they sound happy. Now that they getting more used to working together I see them starting to get past just trying to get the answer and looking at understanding what is really going on in chemistry. They will talk about what is happening in a chemical reaction—what the changes are and how they happen. They get to talking together, working together, and you can see the expression in their faces that they know they can do this. (Jeff)

In this description, Jeff explained that he had to encourage his students to work with each other. He also described his methods in using collaborative groups to help students develop better answers. As a result of effective collaboration, his students showed behavior indicating enjoyment, a responding level behavior.

David also described students demonstrating enjoyment during collaborative activities. When asked about the types of affect he observed when his students worked in groups, David responded:

> Enjoyment—they come to life, their faces, the way they talk to each other and laugh. It was fun to see groups that don't normally work with each other, and then they get into it. They get into a whole different activity [in groups] than what they would normally be doing [individually] and they get along. They are enjoying what they are doing and they build a connection with each other that they wouldn't have without the group activity. I would say every group—I give them a chance to write a reflection at the end of every project and I didn't have one say that they didn't like working in their group. (David)

Ellen reported her students demonstrated behavior at the responding level in the form of satisfaction in accomplishment. She described her students experiencing a sense of accomplishment after working on difficult concepts in physics: "The strongest response…is the realization that they have figured something out collectively, or struggling with something for a long period of time and finally understanding a concept."

In the preceding accounts of student collaboration, teachers described students demonstrating responding behavior in the form of willingness to work, enjoyment, and satisfaction in accomplishment. Teachers suggested that students demonstrated responding level

behavior as a result of working in groups. In the next section, the researcher examined conversation as another type of interaction that influenced student affect.

Conversation for Improving Attitude

Six of the eight teachers described conversations as a way to improve student attitude. Teachers indicated that conversations built students' trust and confidence in their ability to learn science. Based on these teachers' descriptions and the researcher's observations, the researcher identified conversation as relaxed and casual exchanges between the teacher and the students or among students. The topic of the conversation sometimes began with science and drifted into other areas such as students' lives or events at school unrelated to science. In contrast focused discussion centered on the current unit of study. The researcher identified focused discussion as a discussion led by the teacher and concentrated on a specific topic. In focused discussion, the teacher controlled the dialog, keeping it directed toward the topic of study.

The six teachers who used conversation explained that conversation influenced student attitude and made it possible for students to respond to their instruction. Sarah believed it was necessary to build student trust before her students would develop an interest in science. She explained how students who struggled in science thought about contributing to class discussion:

> [They are] not normally the highest achieving kids.… A lot of them have not had good experiences in science before. They have not done well. I have kids that sit there and go, 'Well I just can't do science.' So there is this wall to overcome to get them interested. (Sarah)

Sarah was emphatic that conversation developed her students' confidence in their ability to share their ideas to others in the classroom:

> It's a conversation! … Once they get into that and realize that when they find something cool I'm open to hearing about it, that I want to talk to them about it, they will call me over. 'Mrs. _____, you've got to see this.' And we will talk about that. (Sarah)

Sarah believed that interacting through conversation allowed her to reassure the students that she was interested in their ideas. She indicated that conversation was a safe venue for her students to talk about their ideas and understanding of science. Sarah described using conversation to build student trust and confidence in their abilities:

> I will throw questions out, and we will just start exchanging ideas. Or when I want to see how much they know, I will put up questions, and we will end up talking about some things. I can't do that early on because most of the students won't open up, because they know they can't do science. So they are not going to contribute because, 'What if someone laughs at them? What if it's a stupid idea?'… So I have to build through the course of the semester to get to that point. I've got to build that trust with them that they can bring their ideas, and it will be part of a conversation and not something that they will get picked on later. (Sarah)

In the previous account, Sarah explained that some of her students did not have confidence in their abilities in science. She suggested that they hesitated to speak up or share ideas in the classroom for fear that the other students might make fun of them later on.

Ellen explained the use of interaction in her classroom, describing conversation as a way to learn what students were thinking. She explained her desire to get students to communicate:

> I work the first couple of weeks of school cultivating interaction. If I can get them to interact back and forth with me, I will find out what they are really thinking. And if they tell me what they are really thinking, I can work to get them going in the right direction.

> I'm very tangential, and I can change directions multiple times. If I let it get off [topic] on occasion, they are going to be more comfortable when I bring them back. Whereas if *you* shut everything down, they are going to get frustrated, and *they* will shut down. (Ellen)

In this account, Ellen explained the need to allow students to converse off topic to build their confidence in their abilities. By describing herself as tangential, Ellen illustrated her ability to follow student conversation, allowing it to move in different directions and still be able to bring the conversation back to the topic of instruction.

Greg used conversation to encourage interaction between students and help them work more effectively in collaborative groups:

> At the beginning it's a lot easier said than done to put them in groups and force them to work with each other for a while.… Getting to know each other took a while. But I think conversation really helped open up ideas and different ways of thinking. It wasn't just the fact that science students work together on experiments. It was that they were talking to each other, getting to know each other. (Greg)

Teachers also used conversation to build student comfort levels and encourage interaction as negative affect surfaced in the study of controversial topics such as evolution and geological time. Louis described talking to students to improve their comfort levels in the study of geological time:

> After the first day or so, they start to realize I'm not challenging their beliefs. We talk about it and they get comfortable with that. I let them talk about what they believe if they want to. They realize I'm not trying to change them. After that they don't seem to mind listening to the evidence. (Louis)

The researcher observed conversations in four teachers' classrooms and noted the informal tone and interactions that occurred. Teachers initiated conversations with questions about the topic or events of the day. During conversations students responded to the teacher or each other. Side conversations were ongoing between students. In observations of David's biology classes, the researcher was able to observe a focused discussion and a conversation. David began the conversation by asking what students had done over spring break. While some students answered David's questions about spring break others were talking with each other. David transitioned to note taking, asking students to take out their notebooks and review their notes from the previous day in preparation for an activity. The students reviewed notes while the conversation continued. During the conversation, the topic, at times, was about biology, but not always. David occasionally asked questions and made comments to tie the conversation into the topic of study. Students appeared happy and animated. An observer who entered the class might not recognize that students were working on an instructional activity. After the conversation, David transitioned into focused discussion. David used a presentation to guide the students in taking notes on human inheritance. Students were quiet and cooperative, and David was able to present a large amount of information.

The researcher was able to observe conversations in Sarah, Ellen, and Louis's classes. In these classes, the teacher began the class period with an activity that started conversation between students. Teachers were able to transition to related topics as the conversation continued. In Ellen's class, prior to a lesson on light frequency and color, Ellen gave each student a paper on which she had written an emotion, such as anger or joy. She asked the students to assign a color to the emotion: "Choose a color that portrays that emotion. Purple—is it K-State purple? Is it purple with a little bit of pink? Describe it using more than 15 words."

This activity provoked active talking and laughter among the students. Ellen continued to converse with students on colors for several minutes before bringing up the lesson topic of light frequency.

During an observation of Sarah's class, Sarah began a conversation by talking about the tarantulas in her room: "I am hoping to trade one of my tarantulas for a bird eater. Does anyone know why we call it a bird eater?" This prompted active conversation among the students that Sarah allowed to continue for several minutes. She returned to her conversation about the tarantulas, commenting that she knew some of the students might have a fear of spiders and noted that they would be observing and not handling the spiders. As with Ellen's class the conversation became lively with students talking to each other and laughing. After several minutes, Sarah explained that students would be working on an activity observing the various animals in the room. At this point, students showed a willingness to listen to instructions.

These relaxed casual exchanges, identified by the researcher as conversations, were an important part of classroom instruction for six of the teachers. Conversations helped teachers to improve student attitudes toward science levels by building students' trust in the teacher and confidence in their ability to learn. In the next section, the researcher presented examples of changes in student affect during classroom activities.

Affective Progression

As the researcher analyzed data, themes emerged of students' changing levels of affect. In analyzing patterns of affective change, the researcher identified a subtheme of *teachers developing affective progression*. This theme developed from teachers' reports of student behavior changing from compliance to willingness to respond in the context of lessons and

activities created by the teachers. The researcher defined affective progression as changing behavioral responses indicating changing levels of affect.

All eight teachers reported affective progression as students moved from receiving to responding behaviors. The researcher found that teachers developed lessons that they associated with this progression in students. Teachers indicated that students progressed from compliance to cooperation during lesson activities developed to encourage interest along with content learning. Seven teachers reported students responding with frustration as the lessons and activities became more complex, requiring higher-level cognitive tasks. After working through a period of frustration, students were able to persevere and continued the progression to higher sub-levels within the responding level. Five teachers reported the progression continued into the valuing level. In their reports of affective progression, teachers described lessons that accompanied or facilitated the change. These lesson descriptions typically began with introductory activities followed by more complex activities and higher-level affective responses from the students. Teachers described their students developing the ability and desire to work out of interest rather than compliance. In the process of developing interest the students became self-starters and expressed enjoyment and satisfaction indicating progression into the responding level. As students accomplished more complex science activities they showed behavior indicating appreciation and valuing. In the following sections, the researcher provided examples of affective progression.

Receiving to Responding. All eight teachers described affective progression from receiving into responding in the context of lessons and activities designed to move students from introductory foundation knowledge about the topic to a more complex synthesis of the acquired knowledge. As students applied the knowledge they had learned to more complex lesson

activities, teachers noted that the affective behavior progressed from receiving to responding. Teachers indicated that the process of moving from receiving to responding was not automatic. It required active planning on the part of the teacher. When asked how she facilitated affective progression from compliance to willingness to work on their own, Ellen commented on the need for a carefully planned activity:

> In order for it to happen, it's got to be hands-on and it has to be set up in such a way that they can go further on their own. And the additional key to that is that it has to be something that piques their interest. If they already understand how it works, unless it's fun to mess around with, they are probably not going to go any further. It's like it's got to be the right topic and set up the right way. (Ellen)

In this quotation, Ellen noted the importance of planning an activity that allowed students to continue with the activity "on their own," meaning without prompting or instruction from the teacher. She suggested that carefully planned hands-on activities that led the students to discover a process ("how it works") facilitated that progression from receiving to responding.

In providing an example of affective progression from receiving to responding, Louis described a complex assignment: "We went through the five steps of solving an ecological issue: research, analyzing risk and coming up with solutions, political awareness and change, public education, [and] analyzing results of the solution." Louis's students were required to use and apply foundation knowledge to create a letter to a public official about an ecological issue: "We did an ecology project where we did a week on an ecological issue, and the students had to contact a government official about their research to try to enact some type of change or awareness." Louis explained that his students initially researched the topic realizing that they

would apply the knowledge they learned in a letter expressing a position or need. He noted that the students were initially reluctant to research the topics:

> The first half [of the unit] was just research. I had articles for them to read. In the beginning that's what they did. We just read about that issue. They didn't want to read the articles but they knew they had to do it. But they started to get more into it as they went along. … I used the political action part of it as leverage. 'You are going to write to a governor or a member of the cabinet, and you need to sound like you know what you are talking about.' It kind of spurred them on. They knew they needed to really understand the topic beyond just the basics. But as they got into it, they took ownership of it. (Louis)

Louis's students were aware of the requirement that they apply their basic knowledge. Louis described the progression from compliance ("they didn't want to read the articles, but they knew they had to do it") to responding ("they took ownership"), noting that the realization that they would apply the information helped the students transition into interest and ownership of the project. Louis's students eventually demonstrated excitement in the product that they created in the project.

Jane believed that progression from receiving to responding required deliberate lesson planning on her part. When asked about students progressing from compliance to willingness to work, Jane noted that creating lesson plans with guidelines that helped students understand her requirements led them to appreciate the difference between knowledge of basic chemistry and understanding the processes:

> One of the activities we did was discovery of the atom. I made this a group project. I assigned each group a discovery about the atom and they had to develop a [presentation]

> and teach the rest of the class.… I would say they don't at first understand the differentiation between the general principles and the language of explaining the process. I think they just go through the motions as we start on a unit. They do as little as they can. As we get into relationships, it really hits them that, 'I really have to pay attention. I really need to understand the differences in the terms and what it all means.' (Jane)

Jane suggested that her students initially didn't understand connections between the basic knowledge that they learned and the overall processes. But as they continued to work on the assignment they recognized the need to understand those connections or "terms and what it all means."

When asked for an example of the type of lesson progression in which his students moved from compliance to responding, Jeff described an introductory assignment designed to build foundation knowledge:

> I'll hit the high points, just the main ideas of the chapter, and key ideas on the first day. It doesn't take that long to get through that.… I set up study guides and some guided reading to get them through there. (Jeff)

Jeff indicated that the purpose of the introductory assignment was to "get through" the key ideas. Jeff noted his students' compliance along with his goal of helping students to be more self-sufficient: "Generally if I assign it they do it, for the most part. I use [computer based assignments] so they can get the assignment and work on it and submit it independently. I try to get them to be more independent." In this quotation, Jeff described compliance along with his desire to help his students become willing to work. As Jeff continued his description of the lesson, he described his students progressing from receiving to responding in terms of moving from compliance to willingness to work. He explained that he wanted his students to become

less dependent and more willing to work without pressure from him. To accomplish this, he created open-ended questions and required that they work together in collaborative groups:

> I wanted to make them responsible for learning the material, so I created open-ended questions. They have to answer the questions by explaining what they know…. They have to put together the terms that they learned at the beginning of the chapter…. It was when I made them work in groups that they started working more independently. They would come in and get started talking about the questions without me even saying anything. (Jeff)

In the previous statement, Jeff described students becoming willing to work without pressure, a responding level behavior. As the learning activity became more complex and required applications of prior knowledge, some students became uncomfortable with the assignment. But as they continued to work, they became more comfortable and skilled, gradually progressing to willingness and then satisfaction. Jeff gave this account of the progression:

> They have a post [follow-up] assignment that has more complex questions. That's when they start to get uncomfortable. They have to use what they know to explain applications…. I had to push them a little bit when we first got started. Some of them wanted to work by themselves. But I keep encouraging them to work with each other, and that is where I am seeing more enjoyment, more satisfaction in their work. (Jeff)

Jeff's account of students progressing from compliance to enjoyment in their work represented affective progression from the receiving to responding level. He recognized their discomfort in the cognitive requirements of the assignment. Rather than providing cognitive assistance by giving hints or answers, he focused on the affective domain, encouraging them to persist and to collaborate. The result was that his students progressed to enjoyment and satisfaction.

Sarah noted the importance of the discovery process in describing how she led her students through affective progression from compliance to willingness to respond:

> A lot of the projects that I set up, at the beginning, I give them very straight guidelines and most of the kids will just follow that and not go beyond. There are always that portion of the class that once they get into the web pages and research, go a step further. And it's that discovery that I am trying to build into the project so that even the kids that aren't the high achieving kids will start looking at things and going, 'Wow that's really cool,' and look at more of that. And it may not end up in their final project. But it's the journey and not the final project that sometimes is more important. (Sarah)

In her explanation, Sarah considered the progression of student affect to interest and enjoyment to be more important that producing a final project.

Frustration Response. Five of the eight teachers identified a point in the progression where the students became uncomfortable and frustrated, reacting negatively both in word and body language. This happened as assignments became more complex and as the teacher required that students work without direct instruction. Over time, the students persisted in the task, realized they could complete it, and moved on to enjoyment and satisfaction. In analyzing this phenomenon of frustration response, the researcher found that teachers reported their students regressed from the responding level back into the receiving level during their frustration response followed by progressing back to responding. Jane commented on students progressing through frustration in lessons requiring problem solving:

> They just would get very frustrated because they wanted direct instruction. Once they knew that they had to figure it out, that I wasn't going to do it for them, and once they got

going and figured it out, they just kept going. They get pretty talkative. You can tell by the expressions on their faces. (Jane)

Greg described his students' negative talk and the support from students in the group as they became frustrated with some math activities in his biology classes.

> They would get really frustrated with some of the things. One of the things they would say is, 'I give up. I'm never going to get this type of thing.' And the others in their group would say, 'Yes you are. You just need to keep trying. You just need to know what you are multiplying.' They would help those that needed help. They would encourage each other. (Greg)

Ellen described her students' frustration as they progressed into more difficult physics concepts:

> I have to say the most frustrating topic is two-dimensional kinematics, or in AP Physics the most frustrating topic is electric fields. Because there is so much that they haven't seen before; because we aren't just asking them to visualize an electric field that they haven't seen before. We aren't just asking them to visualize the field, but fluctuations in the field. … And you have so many more things you can't reach out and touch. It just gets really hard. So right now, my kids are really frustrated. (Ellen)

Ellen believed that discomfort or frustration helped her students to progress to higher levels of affect. She commented on student frustration changing to interest and determination to solve a problem:

> The thing that helps seems to be frustration. If someone is frustrated with something, they're going to say, 'Hey I don't get this it bugs me. I want to figure it out.' And

sometimes that can kind of be enough to get everyone going, 'Oh yeah, how do you do that?' And then it will kind of get the ball rolling. (Ellen)

Ellen noted that her students were able to progress from frustration to responding behavior after solving a problem:

Typically, the students are struggling with questions. You will see them say, 'Yeah!' And pump their fist. Because what that means is they just got their answer to match up with what the answer is supposed to be. They have navigated from the beginning to the end of the problem. In AP Physics, kids get incredibly frustrated. And all of the sudden they break through on something. They switch over to the feeling of satisfaction and almost euphoria, 'Yeah! I got it!' (Ellen)

Jeff described his students demonstrating frustration in assignments as he shifted responsibility for learning to them. He noted they were no longer compliant and showed unwillingness to work without direct instruction:

They are talking mostly amongst themselves and … I get the feeling that they think this should be a lot easier. I tell them that this isn't especially difficult, but you do have to work at it. I think a lot of them don't feel that way…. A lot of [students are] just sitting there, frowning, not talking. They are not willing to work on it very hard. (Jeff)

Jeff reported that his students became more comfortable and exhibited satisfaction in accomplishment after a period of discomfort:

The follow up assignment is where I am seeing more satisfaction. It is more open-ended, more of an application. They have to explain what's going on, and that makes them really uncomfortable. But I'm OK with that. We are kind of cycling through that. It took getting them to go through this period of being uncomfortable. And they realize I'm OK

with that. And then they are able to get it, figure it out, and they are satisfied with what they have done. They are kind of cycling through that. They are learning more. They understand that there is more to it than just getting it done. (Jeff)

As Jeff's students became comfortable with the assignment, he noted their change in attitude and their enjoyment in their ability to understand chemistry:

> They aren't just sitting around. They talk to each other. They look happy and they sound happy. Now that they getting more used to working together, I see them starting to get past just trying to get the answer and looking at understanding what is really going on in chemistry. They will talk about what is happening in a chemical reaction—what the changes are and how they happen. They get to talking together; working together and you can see the expression in their faces that they know they can do this. (Jeff)

David described a vivid experience in frustration response during an ecosystem project. His students completed the introductory activities in a unit on ecology in which they progressed through receiving and responding behaviors. After completing these knowledge building activities, the students entered the classroom to find gallon jars, gravel, a tank full of water, algae, fish, snails, and other supplies. Students were assigned to groups of six and told to create an ecosystem with the materials provided based on the knowledge they had acquired in the previous week. David explained, "The only requirement is that they have a jar and a fish. They put them together with the goal of seeing whose fish can last the longest. Some of them have lasted two months now." After instructing them to create their ecosystems David told them to get started and disengaged himself from directing the project. David described his students showing frustration responses:

> The first day when I presented the lab there were lots of, 'I don't want to do this,' lots of groans. 'I can't believe you're not giving us a lab report. Give us directions.' I had buckets of water. The tank was full of fish, snails, and plant life. I had gravel. I had buckets just lined up on my board over there. They were kind of in shock. 'I don't know what to do. I don't know what an ecosystem is. I can't believe you didn't give us a lab report.' And they just had to work as a team. I had to bite my tongue. So they put them together and 24 hours later, they come in and find a bunch of dead fish. So then their interest level increased right there. 'Ours are surviving. Why are theirs dead, and ours are still alive? How are they different?' I think once they saw a dead fish in 24 hours, then they started thinking about it. (David)

David's account suggested that the failure of some of the ecosystems to keep the fish alive changed his students' attitudes toward the project. When asked what helped them persevere with the project, David suggested they recognized the problem solving nature of the activity:

> I think a lot of it was the realization that this was a problem to be solved and that they knew enough from their prior work to solve it. And I think their interest helped them get past the frustration and move toward wanting to figure this out. (David)

Not all of the teachers described frustration response in the context of affective progression. Sarah believed her students needed assistance to decrease frustration, and she believed that frustration hindered their learning:

> [Some students] are very much at the frustration level when they come in. So they need to be helped along when they get frustrated. So I give them group projects, especially something hands-on, not individual assignments. There is usually at least one person in the group who is willing to think a little bit more and help the people around them a little

> bit. So it's not a lone journey. I don't think that most of these kids can do a lone journey. They would be at that frustration level and just shut down. Because in the past they haven't been successful making it past that anyway so why bother. But if they've got friends around them that they are helping each other through that then they can go forward and enjoy the project rather than shut down. (Sarah)

In her preceding statement about student frustration, Sarah suggested that just being in a science class already frustrated some students. Sarah noted that some of these students had not been successful in their previous science classes. Taking this into account, the difference in Sarah's account of student frustration and the other teachers may have been due to Sarah's sensitivity to some students' negative attitudes because of their previous experiences. Sarah, like the other teachers, reported that she created lessons to increase student interest as well as build student confidence and enjoyment.

Responding to Valuing. In five teachers' reports of affective progression, students were able to move into the valuing level. As students successfully completed lessons and assignments, they showed a greater appreciation for the topic and demonstrated that appreciation in their willingness to work beyond the teachers' requirements. Louis's students showed valuing by creating products that were exceptional and continuing to show interest beyond the requirements of the assignment:

> What they created, some of them were so good, and I've got to believe that they were satisfied [because of] the expressions on their faces when they presented. I had kids bring me articles after they were done. One of the issues was about fracking, and I had a couple of people brought me articles that they had noticed about the project. They didn't

say, ‘This is done; I’m done with the topic.’ Instead they saw information about it later and they brought it to me. (Louis)

In David’s ecosystem activity, students showed valuing behavior in their continued interest and willingness to participate beyond the requirements of the lesson. Students observed and recorded data daily, describing the changes that took place in the jar and the surviving organisms. Over time the students took ownership of the project, demonstrating pride in accomplishment and confidence in their abilities. They continued to work with the ecosystems for weeks after the assignment was completed:

> Some of them have lasted two months now. I have students come in every day so interested to see if theirs are still going. They have taken huge ownership of that. They can tell you everything as to why their ecosystem is still alive and why some have died.
>
> We are not even studying it any more but that is the first thing they do every day is check on the ecosystems that are still alive. The first thing they do, especially that one [pointing to an ecosystem jar that is filled with so much green algae that the fish is barely visible]. How is it [the fish] still alive? It’s kind of blowing me away. (David)

At the time of the researcher’s observation, David’s class had moved on to other topics, but the students still checked the few remaining viable ecosystems. The researcher observed this behavior in a classroom visit. At the beginning of the class, some students entered the room and immediately got out their notebooks and went to the counters where the ecosystems were displayed. They observed the ecosystems and recorded data in their notebooks before class started. David noted, “We have finished talking about it, and they are still writing stuff in their notebooks.”

Jane described her students progressing from frustration into responding and then valuing levels of affect as they worked on a project requiring that they demonstrate the value of science:

> I gave them a final project in which they had to answer: Why do people need science? They had to come up with and demonstrate ten activities that they can do with kids related to science. They want direct instruction. They get really frustrated because they want me to tell them exactly what to do. Then they start working on a project and they get real excited. At the end they want everyone to see their work. They want me to see what they did.… For some students you could see the value because they were really interested in what they were doing, because of the discussion they were having in their groups…. They would actually pull applications into class and ask questions. Some of their questions were very advanced (Jane)

In her description, Jane recognized that showing advanced interest represented valuing behavior. She noted that the frustration response preceded student progression from responding into valuing.

In examining these accounts of affective progression, the researcher identified a pattern based on teachers' experiences:

1. Preparation: Students acquired foundation knowledge and worked on developmental assignments.
2. Cooperation: Initially students responded to the assignment with cooperation but not appreciation.
3. Frustration: As a problem or project becomes complex, students responded with frustration.

4. Persistence: Students persisted and became comfortable with the task. The classroom atmosphere became busy and enjoyable.
5. Accomplishment: Students solved problems, made connections, and reached conceptual understandings. They demonstrated satisfaction in their ability and accomplishment.
6. Appreciation: Students showed appreciation for the topic, advanced interest, and work beyond the teachers' requirements.

The steps in the progression and the levels of affect that they represented based on Krathwohl's Taxonomy were shown in Table 4.4. As shown in this table, affective progression was not a continuous rise to higher levels, but regressed back to lower levels when students experienced frustration. However, based on teachers' accounts, students returned to higher levels of affect with support from the teacher and each other.

In considering the researchers' finding of affective progression in teachers' reports, it is important to note that progress to higher levels of affect did not always require collaboration and was not always preceded by frustration response. However, some teachers felt these two conditions were important in the process. Further, it is important to note that all interpretations within the process of affective progression are subjective, in that one person might identify responding where another might see valuing.

Table 4.4 Affective Progression

Student Response	Affect Level
Preparation – Acquiring knowledge	Level 1 – Receiving 1.1 Awareness, 1.2 Willingness, 1.3 Selective attention
Cooperation	Level 2 – Responding 2.1 Acquiescence
Frustration	Level 1 – Receiving 1.3 Selective attention
Persistence	Level 2 – Responding 2.2 Willingness
Accomplishment	Level 2 – Responding 2.3 Satisfaction
Appreciation	Level 3 – Valuing 3.1 Valuing, 3.2 Preference, 3.3 Commitment

Summary

In the initial coding of data, the researcher classified types of student affective behavior reported by teachers within the framework of Krathwohl's Affective Taxonomy.

The researcher found that teachers observed affective behaviors that represented all levels of the Affective Taxonomy. All eight teachers reported behaviors in the receiving and responding levels. Teachers considered the receiving level to be an important foundation in development of student affect and described student behavior as compliance with required assignments and activities. Student behavior in the responding level indicated that students were cooperative and willing to work. Teachers reported that students were happy and working of their own volition.

The second most reported level of affect was the valuing level. Six of the eight teachers reported behavior indicating valuing. At this level students exhibited high interest and commitment to work above and beyond the requirements of the teacher. The researcher found organization behavior to be third most reported behavior. Student behavior at the organization level indicated students were considering values and making comparisons. The researcher found that teachers described behavior involving reaction to perceived controversial topics at the organization level. Student body language in the form of posture changing from closed to open appeared at this level as students compared and organized beliefs and values. Only three teachers reported behavior that the researcher identified as characterization level.

In analyzing teachers' reports of student affective behavior for emergent themes, the researcher was able to identify an overarching theme of *teachers working with student affect through interaction*. The researcher found that interaction through collaboration and conversation was a mechanism for teachers working with student affect. The researcher also found interconnecting sub-themes among these data: (a) use of affect to gauge student attitudes and improve instruction, (b) management of affect with controversial science topics, (c) collaboration for development of responding behavior, (d) conversation for improving student attitudes, and (e) teachers developing affective progression. The researcher found evidence of teachers using student affect throughout the data. All eight teachers reported that they actively watched for and encouraged affect. Affective responses were considered valuable feedback for the teachers. They took note of student responses, both negative and positive and considered affect an indicator of how students responded to their lessons. In the study of perceived controversial topics, teachers reported students showing concerns with conflicts between their beliefs and science theories such as evolution. The researcher found that teachers managed

student affect by responding to student concerns and focusing on understanding the science of the topics.

Analysis of these data indicated two key interactions for working with affect, collaboration and conversation. All eight of the science teachers reported that they used collaboration as a way to increase student interest in science. In analysis of these reports, the researcher identified a sub-theme of *collaboration for development of responding.* Another key to working with student affect was through conversation. Five teachers described conversation as a way to improve student attitudes by building student trust and confidence in science learning. Through these reports of the use of conversation, the researcher identified the sub-theme of *conversation for improving student attitude.*

The researcher found an important sub-theme of teachers developing affective progression. All eight teachers described changes from lower to higher levels of affect in the context of lessons and activities they had created to increase student interest. Five of the teachers reported that their students experienced frustration during the learning process but were able to return to responding level behavior. Four teachers reported that their students progressed to valuing levels during affective progression.

Chapter 5 - Conclusions, Implications, and Recommendations

Introduction

In a time when the need for trained scientists, engineers, and technologists is high, investigations show student interest in study of the sciences to be at a low level (National Science Board [NSB], 2006; Organisation for Economic Co-operation and Development, 2006). In the United States, less than 40% of students who enter post-secondary science or engineering finish with a degree in any area in science, engineering, or technology (Business-Higher Education Forum, 2005). Numerous resources have been invested in improving student achievement in science but test scores show poor performance, and student motivation to study the sciences is low (NSB, 2006; Osborne, Simon, & Collins, 2003). Much of the science education research of the last three decades has focused on cognitive objectives rather than attitude and motivation (Bybee, 1995; Garritz, 2010; Noddings, 1996). Teachers have avoided addressing attitudes and values in the science classroom, and emphasis has been to present science in terms of facts and logic exclusive of affect (Alsop, 2005; Krathwohl, Bloom, & Masia, 1964/1984).

A growing number of researchers have called for new studies into the role of affect in science learning (Alsop, 2005; Garritz, 2010; Noddings, 1996; Simpson, Koballa, Oliver, & Crawley, 1995). A need exists to better understand affect and instructional strategies that effectively connect with student affect to develop interest and motivation in the science classroom (Glynn & Koballa, 2006; Miller, 2005; Simonson & Maushak, 2001). With these needs in mind, the purpose of this study was to examine the types of student affective responses that secondary science teachers reported emerged in science classes, how teachers worked with student affective responses, and what interactions were present in the classroom when teachers

worked with student affective responses. The researcher found that teachers recognized student affective behavior representing all levels of Krathwohl's Affective Domain. The findings also revealed how teachers used, managed, and developed affect and the types of interactions that occurred to develop student interest and to influence student performance in the secondary science classroom. In the following sections, the researcher presents conclusions and discussion based on the findings, followed by implications and recommendations. Suggestions for future research complete the chapter.

Conclusions and Discussion

The conclusions from this study follow the research questions and findings of the study. The researcher's conclusions address three areas: (a) relevance of Krathwohl's Taxonomy, (b) use of affect during instruction, and (c) interactions for working with student affect. These conclusions and the research questions from which they were developed are outlined in Table 5.1. In the following sections the researcher presents the research questions, considers the major findings, and presents conclusions from those findings.

Table 5.1 Research Questions and Related Conclusions

Research Question	Primary Conclusions	Supplementary Conclusions
1	Affective Taxonomy was relevant.	Teachers targeted responding behavior.
		Valuing emerged with successful lessons.
		Organization emerged with controversial topics.
2	Teachers used affect during instruction.	Teachers used affect to improve instruction.
		Teachers developed affective progression.
3	Teachers used interactions in working with student affect.	Teachers used collaboration and conversation to develop student affect.

Research Question 1

What types of student affective responses, as identified by Krathwohl's Affective Taxonomy, do science teachers report emerge in science classes?

Primary Conclusion 1 - Relevance of the Affective Taxonomy

Based on the findings, the researcher concluded that Krathwohl's Affective Taxonomy was relevant for classifying observed behavior in the classroom. In developing this conclusion, the researcher found that teachers in this case study reported behavior representing all five levels of Krathwohl's Affective Taxonomy. All eight teachers reported examples of student behavior that the researcher could classify within some level of the Affective Taxonomy based on Krathwohl et al.'s (1964/1984) descriptions. In exploring teachers' reports of affect in the classroom, the researcher did not find that one affective level was the most important to the teachers. Teachers' reports indicated they were interested in and recognized many levels of student affect. However, due to the number of and detail found in teachers' descriptions of the first three levels of the Affective Taxonomy, the researcher found that the three most important affective behavior levels in the classroom were responding, valuing, and organization. The researcher considered these levels important because of the amount of information provided by teachers of student behavior identified with these levels.

Beyond providing examples of affective behavior, teachers revealed an understanding of the nature of student affective behavior. Teachers recognized the relative internalization of affective responses, implying that they recognized levels of affective behavior. They revealed preferences for development of responding behavior because they recognized that at this level, the student had moved beyond compliance to demonstration of interest. Teachers also recognized

that student affective behavior changed during the course of a unit of instruction, and they associated that change with their instructional activities.

Because of these findings, the researcher concluded that Krathwohl's Affective Taxonomy was relevant for classifying observed affective behavior in the classroom. The Affective Taxonomy provided useful and appropriate examples to aid in classifying student affective behavior during instruction. It is important to point out that while Krathwohl's Taxonomy was intended for the development of affective objectives, it unique in terms of identifying affective behavior as it allows teachers and researchers to observe and classify types of affective behavior (Krathwohl, Bloom, & Masia, 1964/1984). Other measures of affect rely on self-reporting using surveys and Likert scales (Anderson & Bourke, 2000; Kearney & Beatty, 1994). Krathwohl's Affective Taxonomy allows teachers and educators with an understanding of the Affective Taxonomy to identify and classify affective behavior in students during instruction (Krathwohl et al., 1964/1984). The use of observation is supported by educational researchers calling for observation as a more appropriate method for understanding the efficacy of instructional practices (Bednar & Levie, 1993; Kearney & Beatty, 1994)

Three important supplementary conclusions emerged within the relevance of Krathwohl's Taxonomy: (a) teachers targeted responding behavior, (b) valuing behavior emerged with successful instructional activities, and (c) organization behavior emerged during the study of perceived controversial topics.

Targeting Responding Behavior. The researcher found that receiving and responding level behavior were the most frequently reported by all of the teachers. However, teachers viewed receiving behavior as an initial affective response to move past, while responding behavior in the form of interest and enjoyment was the target of many lesson activities. All eight

teachers described instructional activities that led to behavior that the researcher identified at the responding level, including enjoyment and willingness to work. Further, five of the eight teachers reported that they had created lesson activities designed to develop student enjoyment and motivation to work on their own (David, Jane, Jeff, Louis, Sarah). As a result of these findings, the researcher concluded that responding behavior was a targeted affective behavior for these teachers. A related conclusion was that these teachers created lesson activities designed to develop responding behavior. These conclusions paralleled Krathwohl, Bloom, and Masia's, (1964/1984) finding that many educational activities were associated with the responding level.

Emergence of Valuing Behavior with Successful Lessons. The researcher found that six teachers reported valuing behavior and of those six, five teachers (David, Ellen, Eric, Jane, Louis) reported students exhibiting valuing behavior in the context of activities in which the students were successful in completing complex lesson requirements. These teachers described lessons requiring capstone activities such as group projects that led to the development of advanced understanding with students demonstrating that they recognized the value of the topic. As students demonstrated advanced cognitive understanding of topics through projects and activities, their behavioral responses indicated they valued the topics of instruction. From these findings, the researcher concluded that valuing behavior emerged with successful lesson activities. This conclusion was supported by existing literature on appreciation, valuing, and attitudes toward learning (Chory & McCroskey, 1999; Kearney, 1994). Appreciation of a topic was associated with advanced understanding of the topic, indicating a relationship between affect and cognition in this affective construct. Evaluation of a topic, a cognitive response, was required for determining the value of a topic (Aiken, 1980; Gable & Wolf, 1993). Attitude

toward a topic of learning was influenced by cognitive understanding of the topic (Anderson & Bourke, 2000; Bandura, 1986; Smith & Ragan, 1999).

Emergence of Organization Behavior during the Study of Perceived Controversial Science Topics. Teachers' reports of organization level behavior were associated with the study of science topics that some students perceived as controversial such as evolution, geological time, and the origin of the universe. All eight teachers in the study reported addressing evolution, geological time, or the origin of the universe in their classes and seven indicated they managed student affect during the study of those topics. Of those seven teachers, five (David, Ellen, Greg, Louis, Sarah) described organizing behavior from their students. This finding is important in that while teachers did not target this level of behavior, these five teachers reported organization behavior during the study of science topics that addressed unifying theories on the origin of the universe, earth, and life. During lessons on science topics such as evolution, students introduced their personal religious beliefs and values associated with origins of the universe, the earth, and life. These five teachers described some of their students expressing concerns with respect to these topics, indicating that those students didn't agree with or didn't believe in evolution or science theories on origins of the universe, the earth, and life. Lesson activities involving presentation of facts about topics such as evolution provided an opportunity for students to examine the facts of evolution and compare those facts with their personal beliefs and values, an organization response. This finding was supported by research recommending that educators acknowledge and work with student beliefs in the study of evolution (Scharmann, Smith, James, & Jensen, 2005; Woods & Scharmann, 2001). As found in teachers' reports, some students expressed conservative religious views with respect to these topics. However, these teachers were able to overcome student dissonance with controversial topics by providing activities that

allowed the students to examine relevant information. The researcher found that these teachers acknowledged student beliefs and used a common process to successfully manage student affect and provide accurate facts about the science of controversial topics. Their reports indicated that students were able to overcome their concerns and became comfortable examining the facts about controversial topics. While these teachers worked to develop students' cognitive understanding about controversial topics, their sensitivity and respect for students' beliefs, reflected in their lessons and instruction, encouraged organization behavior by allowing students to examine both their personal value system and the scientific facts and theories about evolution and origins of the universe. Due to these findings, the researcher concluded that organization level behavioral responses emerged due to teachers' instructional practices during the study of perceived controversial science topics. This conclusion was supported by existing literature on changing attitudes toward emotional topics using factual information (Bybee, 2000; Simmons & Maushak, 2001). Research indicated that addressing student conflicts enhanced instruction of controversial topics, while resolving dissonance between affect and cognition led to changes in attitude and improved learning (Johnson, Johnson, & Smith, 1996; Zimbardo & Leippe, 1991).

Research Question 2

How do science teachers work with student affective responses, as identified by Krathwohl's Affective Taxonomy, in teaching science?

Primary Conclusion 2 - Use of Affect during Instruction

All eight teachers provided examples of using student affect during the course of instruction. Teachers observed student affect to evaluate the success of their lessons and activities and to determine student interest in topics of instruction. They also used activities that developed affect and targeted types of affective behavior. As a result of these findings, the

researcher concluded that teachers used affect during their instruction. This section presents these findings and the resulting conclusions in two sections, (a) how teachers used student affect to improve their instruction and (b) affective progression.

Use of Affect to Improve Instruction. In examining teachers' reports, the researcher found that all eight teachers reported using student affect to gauge student attitudes and evaluate their own instruction. While these teachers had not learned Krathwohl's Affective Taxonomy, they recognized that certain student behavioral responses represented types of affective behavior and they associated that student behavior with interest in learning. Teachers observed student behavioral responses and used them for feedback on interest and attitude toward their lessons. Seven teachers reported that they considered self-starter behavior and talkativeness to indicate students were interested and receptive to their instruction (David, Ellen, Greg, Jane, Jeff, Louis, Sarah). Five teachers considered student willingness to work without being pushed as an indicator of student interest (Ellen, Greg, Jeff, Louis, Sarah). Four teachers reported that they watched for student affective behavior in their facial expressions and body language to determine student attitudes toward instruction and interest in a topic (David, Jane, Louis, Sarah). The researcher also found that seven teachers (David, Ellen, Eric, Greg, Jeff, Louis, Sarah) managed affective responses from students during the study of perceived controversial science topics. To manage student concerns and negative affect, they acknowledged students' personal beliefs and encouraged them to consider scientific facts about controversial topics rather than reject those topics outright.

As a result of these findings, the researcher concluded that teachers actively used affect to improve their instruction by observing and managing the behavior of students. Just as teachers used instructional activities to advance student learning from lower to higher cognitive levels,

such as knowledge to application levels, teachers also used instructional activities to advance students from receiving to responding behavior. This conclusion was supported by existing literature on the use of affect to improve instructional practices (Martin & Briggs, 1986; Miller, 2005; Smith & Ragan, 1999). A related conclusion was that teachers were operating under an ineffective instructional practice in recognizing that student affective behavior was useful but not classifying it within an affective taxonomy. The researcher found that these teachers understood the relative internalization of affect. They recognized that different types of behavioral responses represented different levels of affect. Understanding the levels and the associated behavioral responses of Krathwohl's Taxonomy could assist teachers in recognizing and anticipating types of behavior during critical points in instruction. This conclusion echoes the work of Krathwohl, Bloom, and Masia (1964/1984) that the Affective Taxonomy represents a tool for recognizing and anticipating affective behavior resulting from instruction. Emerging behavior representing student interest could signal that students were ready to move on to more advanced cognitive learning or to activities designed to develop valuing behavior (Aiken, 1974; Isen, Daubman, & Nowicki, 1987; Nieswandt, 2007).

Affective Progression. In examining teachers' reports, the researcher found that these teachers referred to student affect in the context of the instructional strategies and activities that they believed helped develop affect. All eight teachers reported that they observed development of affect from receiving to responding during lessons and activities that they had created to develop student interest. Five teachers (David, Ellen, Greg, Jane, Jeff) reported students experienced frustration and regressed from responding back to receiving levels during problem solving activities or difficult projects. These teachers noted that their students were able to successfully navigate the process of moving back into the responding levels of affect through

collaborative activities. Further, in five accounts of affective progression (David, Ellen, Eric, Jane, Louis) teachers noted that their students progressed into the valuing level. These findings of affective progression were supported by research suggesting that carefully planned and facilitated lessons led to changes in behavior from lower to higher levels of affect (McNerney, Soled, & Kukreti, 2006; Perrier & Nsengiyumva, 2003).

A conclusion drawn from these findings was that teachers viewed affect as changing or progressing and recognized that higher levels of affect could be accessed as students progressed through a learning activity. A related conclusion was that teachers created lessons and activities that developed student affect from the receiving level of affect into the responding levels. These conclusions were supported by existing literature about teachers using student affect to develop interest and motivation in learning (Miller, 2005; Simonson & Maushak, 2001; Smith & Ragan, 1999; Zimbardo & Leippe, 1991). Researchers suggested that cognition and affect were related and that teachers were able to influence levels of student affect (Chory & McCroskey, 1999; Kearney, Plax, & Wendt-Wasco, 1985). A third related conclusion was that frustration experienced while learning and developing cognitive skills was a valuable part of the learning process rather than an attitude to be avoided. This conclusion was supported by literature indicating persistence in completing challenging assignments led students to higher levels of responding and valuing (McNerney, Soled, & Kukreti, 2006; Perrier & Nsengiyumva, 2003). In these studies, students who experienced frustration during the learning process, followed by success in understanding a topic, recognized the value of that topic.

Research Question 3

What interactions do science teachers report are present in the classroom when they work with student affective responses as identified by Krathwohl's Affective Taxonomy?

Primary Conclusion 3 - Interactions for Working with Student Affect

In answering research question 3, the researcher found that teachers identified two interactions as important for working with student affect: collaboration and conversation. The researcher found that all eight teachers used collaboration to develop responding behavior in students. They attributed the development of interest and motivation to working in collaborative groups. While all eight teachers indicated that students were motivated by enjoyment of interaction during group activities, four teachers (Ellen, Greg, Jane, Jeff) noted that students encouraged and supported each other when working together. In a related finding, six teachers (David, Ellen, Greg, Jeff, Louis, Sarah) used conversation to encourage student interaction and participation. These teachers indicated that conversation helped improve students' attitudes toward the study of science by building trust and confidence through interaction.

From these findings the researcher concluded that teachers in the study used interactions to effectively manage and develop desired affective behavior. All eight teachers reported that they managed the instructional activities to create desired affective behavior, and four (Ellen, Greg, Jeff, Sarah) indicated that they worked to create a classroom climate to produce desired results at the desired time. Collaboration and conversation were used to develop affective behavior from receiving into valuing levels. These conclusions were supported by existing literature on the relationship between student and teacher interactions and student attitudes toward classroom instruction (Chory & McCroskey, 1999; Kearney, 1994; Kearney, Plax, &

Wendt-Wasco, 1985; Simonson & Maushak, 2001). In these studies interactions between students and teachers were associated with increased positive attitudes in students.

Beyond providing instruction and trying to develop interest, teachers demonstrated effective classroom management by building rapport (David, Ellen, Louis) and confidence (Sarah, Ellen, Greg) and by encouraging student interactions (David, Eric, Greg, Jane, Jeff, Sarah). The researcher concluded that collaboration and conversation were a part of the operational management of the learning process in that they aided teachers in the development of student affect at the appropriate levels and times needed to successfully build interest, motivation, and ultimately advanced understanding of science topics. This conclusion was supported by existing research into the relationship between teachers' classroom management and students' attitudes (Kearney, 1994; Kearney, Plax, & Wendt-Wasco, 1985; Mallinger, 1998; Stronge, 2007). Operational management in the classroom consisted of providing the appropriate classroom management at the appropriate times to create an effective learning environment (Stronge, 2007). Classroom management styles that encouraged interaction and development of student affect were associated with higher levels of student interest, understanding, and motivation to learn (Kearney, 1994; Kearney, Plax, & Wendt-Wasco, 1985; Mallinger, 1998).

Implications and Recommendations

The findings and conclusions of this study indicated a need for change in the perception of the study of science as reason driven, absent of emotion, and separated from values, as recommended in existing literature (Alsop & Watts, 2003; Garritz, 2010; Nieswandt, 2007; Pintrich, Marx, & Boyle, 1993). Taking into consideration that teachers in this study identified, developed, and managed affective behavior, particularly enjoyment in their classroom lessons and activities, the researcher believes that working with the affective domain has the potential to

impact student interest and motivation in secondary science classes. Due to the need for increasing numbers of college graduates with degrees in science, engineering, and technology and the low retention of students in those degree areas, the researcher suggests that working with student affect can be an effective method for improving student interest and motivation to study and pursue careers in science and related areas. In the following sections, the researcher identifies specific implications for science education researchers, science teachers, and universities as they develop understanding and improvements in secondary science education.

Research Framework

The researcher concluded that Krathwohl's Taxonomy of the Affective Domain was a relevant classification system for identifying and classifying student affective behavior in the secondary science classroom. This framework was particularly relevant as teachers described behavior within the receiving, responding, and valuing levels during lessons created to develop student interest and appreciation. Teachers also described organization behavior during lessons on perceived controversial topics. While the researcher found few examples that represented characterization level behavior, based on teachers' reports, the researcher believed these teachers understood the nature of characterization behavior.

These findings and conclusions are important for researchers in that the Affective Taxonomy represented a framework for research into multiple levels of *observed* behaviors. Krathwohl's Taxonomy lacked constructs such as self-efficacy, attitude, and locus of control. Those constructs were not observable, but were measured through self-reporting, using surveys and Likert scales. Researchers supported the need for observational research into affective behavior. Kearney and Beatty (1994) noted that while attitudes were observable, constructs were measured through self-reporting surveys. Along with Bednar and Levie (1993), they called for

observation as a more appropriate method for research into the efficacy of instructional methods. Krathwohl's Taxonomy characterized affect using behavioral responses, inviting direct observation and identification of student behavior during instructional activities and making the Affective Taxonomy a useful tool for evaluation of student affect. Further, Krathwohl's Taxonomy complemented and extended existing research into student affect by allowing examination of a range of observable student behaviors and student progress over time as suggested by McNerney, Soled, and Kukreti (2006). Findings of this study as well as existing literature on affect in the classroom indicated that student affective behavior changed quickly depending on factors both inside and outside the classroom (Chory & McCroskey, 1999; Mallinger, 1998; Noddings, 1996; Perrier & Nsengiyumva, 2003; Rosiek, 2003). This fluid environment required observation of student behavior before, during, and after instructional activities. Examining student behavior representing multiple levels of affect and progression through those levels during the study of science topics could provide a broader, multidimensional view of the influence of affect in the science classroom.

Secondary Science Teachers

While research into science learning may improve understanding of student affect, for the practicing teacher, a need exists for instructional strategies that impact student interest and motivation in addition to achieving cognitive gains (Alsop, 2005). The findings and conclusions of this study indicated that multiple areas of classroom practice could be influenced through using, developing, and managing student affect.

Findings in this study indicated that these teachers were actively using affect in their classrooms, supporting findings of other researchers that teachers observed and used affective responses to determine student interest in their lessons and activities (Chory & McCroskey,

1999; Smith & Ragan, 1999). The teachers in this study observed and used affective responses to determine interest and serve as feedback from students on the success of their methods and lessons. They also used instructional activities that targeted student affect with the goal of developing student interest, motivation, and ultimately success in science learning. Taking this into consideration, the researcher suggests that teachers should be educated to use the Affective Taxonomy to observe and identify student affective responses to their instruction. Further, creation of lesson activities that use and develop desired affective responses can assist science teachers in creating interest and motivation. The researcher contends that affective and cognitive instructional activities could be developed together allowing teachers to observe affective behavior and evaluate both affective responses and cognitive gains (Bloom, Madaus, & Hastings, 1981). Additionally, just as Bloom's Cognitive Taxonomy provides a universal language for teachers to communicate and share lessons and activities targeting the cognitive domain, Krathwohl's Affective Taxonomy provides a language for communicating and sharing activities that work with the affective domain of learning (Bloom, 1986; Krathwohl, Bloom, & Masia, 1964/1984).

The researcher found that certain instructional practices brought out and developed affective behavior. Collaboration influenced student interest, enjoyment, and persistence, while conversation developed trust and confidence leading to improvement in student attitude. This finding was supported by research into classroom management practices (Chory & McCroskey, 1999; Kearney, Plax, & Wendt-Wasco, 1985). According to these studies, students' feelings of trust and their interactions with their teachers correlated with students' interest in and positive attitude toward a topic of study. The researcher recommends that teachers incorporate collaboration and conversation into their instructional activities to create a climate for affective

development and progression. The researcher found that teachers in the study used lessons and activities created to develop affect from receiving into and through responding levels. The researcher would suggest that creating activities that encourage affective progression could influence student interest and motivation to study science.

The researcher found that teachers managed affect during the study of perceived controversial topics by acknowledging students' beliefs and by presenting facts about those topics. Teachers helped students overcome their concerns about the conflicts with their religious beliefs. This type of instructional practice was supported by research of Scharmann (2005) and Van Rooy (1993). The researcher would suggest that teachers' management of affect led to success in learning about controversial topics. The researcher submits that teachers could create lessons developing organization behavior while learning the facts about topics such as evolution. This recommendation was supported by the research of Bybee (2000), Simmons and Maushak (2001), and Van Rooy (1993). Encouraging students to examine the facts about these topics without challenging their personal beliefs could encourage organization behavior. Characteristics of organization behavior, such as examination and comparison of values could become valuable skills transferable to other school subject areas.

Programs for Teacher Preparation in Science Education

The findings of this study suggest that teachers are using affect in the classroom although in an uninformed and inefficient manner. Teachers are uninformed in the sense that they are not educated in the use of an existing framework for the Affective Taxonomy and inefficient in that an understanding of the levels of affective behavior could allow them to manage student affect and create affective progression. These findings have positive implications for teacher training programs in science education. The process of creating lessons related to Bloom's Taxonomy of

the Cognitive Domain is well established in educational institutions (Bloom, Madaus, & Hastings, 1981; Bybee, 1995; Bybee et al., 2006). Integrating Krathwohl's Taxonomy of the Affective Domain into this process creates another dimension of science learning allowing the development of a more holistic approach to science education as supported by Garritz (2010), Noddings (1996), and Simpson, Koballa, Oliver, and Crawley (1995). The researcher's findings suggest that these teachers have already created lessons building on student affect to achieve cognitive results. This is supported by existing literature on affect and science instruction (Bloom, Madaus, & Hastings, 1981; Bybee, 1995; Bybee et al., 2006; Smith & Ragan, 1999). Programs of teacher education can inform science teachers by developing a framework for integrated cognitive and affective educational objectives. In support of this, educational researchers have called for the integration of the cognitive and affective objectives and instructional practices in science education (Kearney & Beatty, 1994; Martin & Briggs, 1986; Zimbardo & Leippe, 1991). In developing integrated objectives, levels of desired affective behavior could be associated with particular cognitive levels of learning. Further, science educators could integrate lessons that develop affect into existing science education standards and assessments. Finally, educators could determine how affective behavior fits into educational goals, particularly, what affective behavior is desirable and should be developed as a part of a complete education. While the researcher considers these modifications in teacher education methods to be modest, she believes they have potential to have great influence in developing motivation and interest in science learning within the next generation of science students.

Suggestions for Future Research

The findings of this study are significant for understanding how teachers observe, develop, and use affective behavior in the science classroom. However, future research is needed

to examine more specifically the relationship between affective and cognitive learning and how to integrate affective and cognitive learning into the science classroom. The need for research into the relationship between affect and cognition is recognized and supported by existing literature (Alsop, 2005; Alsop & Watts, 2003; Kearney & Beatty, 1994; Simonson & Maushak, 2001). While teachers in the study indicated that students were successful at developing cognitive learning and connections with the content of instruction, their reports were related to observations of student interest and satisfaction in learning. Research is needed to examine the relationship between affect and successful cognitive learning. Further, research is needed to determine the nature of integration of affect and cognition in the classroom in terms of the impact on content internalization and retention. Teachers in the study described instructional activities created to develop student affect from receiving into responding. Further research is needed to gain a more thorough understanding of the instructional activities that lead to affective progression and how that progression affects cognitive learning. While the teachers in this study described collaborative projects and capstone activities as integral to development of affect, research is needed to determine the influence of other types of activities on affect including those that are more basic and less innovative and open-ended.

Additional research is needed to develop an understanding of the nature of behavioral responses associated with the study of perceived controversial topics. The findings of this study showed that teachers were able to manage the negative affect that some students developed during the study of topics such as evolution by acknowledging students' beliefs and presenting scientific facts associated with those topics. Additionally, the researcher identified organization behavior emerging in the study of those topics. However, a more comprehensive view of the

types of affect that occur in studies of those topics is needed to create successful affective learning in secondary science education.

The findings of the study indicated that teachers did not commonly observe the characterization level. Research is needed into characterization behavior in the secondary student. Maslow (1964) suggested that characterization is a growth process rather than a trait that is either present or absent as indicated by Krathwohl, Bloom, and Masia, (1964/1984). The researcher speculated that characterization might be partially developed in secondary students just as responding and valuing behaviors did not always appear to be completely developed. If characterization is partially developed in adolescence rather than a product of a completed value system, future research could investigate how it develops and how teachers can recognize and support that development.

Due to the need for increasing the numbers of students motivated to study and pursue careers in science, a suggested area of research is gender and cultural aspects of affect in science learning (NSB, 2006). An understanding of how affective responses differ between male and female students would contribute to scholarship in the area of gender issues in science education (Sanders, 2003; Sanders, Koch, & Urso, 1997). Further, an understanding of culturally and ethnically diverse students' behavioral responses to science topics would contribute to needed scholarship in the field of culturally relevant science, technology, and engineering (Ladson-Billings, 1995).

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Appendix A - Selection Questionnaire

Date

Dear _____,

I am working on a project to investigate teacher reports of affective responses in the science classroom. Affective responses represent emotion, feeling, or degree of acceptance or rejection. As science teachers, we see and often encourage affective responses from our students.

Examples of affective behavioral responses that I have observed in science classes include students becoming interested in astronomy to the point that they spent time at night locating and identifying stars and planets, students expressing genuine concern and dismay over the plight of an endangered species, and students indicating satisfaction in mastery of a difficult problem in physics. I am interested in verbal or behavioral responses that you have observed in your students' reactions to your science lessons. The questions below begin with lower level affective responses and progress to higher levels. They are designed to gain insight into your experience with affect in the science classroom. Please feel free to elaborate or respond beyond the scope of the questions as you think of examples that represent what you have experienced with your students.

Please respond to the questions below and send your responses to me at grauerb@ksu.edu. I hope to receive all responses by February 1, 2013. If you have any questions, please email me.

1. Have you observed an activity or lesson in which your students demonstrated a positive emotional reaction or feeling of satisfaction in accomplishment or completion of the requirements or study of the lesson? (For example, "I did it!" or "That was awesome!")

   If so, please describe the activity or lesson and how the student responded whether in word or behavior

2. Have you observed an activity or lesson in which a student became so excited or involved in the topic that he or she continued work on it beyond the period of study or outside the classroom setting (beyond a regular homework assignment)? (For example, you have completed the study of rockets, and a student tells you about building rockets on her own at home.)

   If so, please describe the lesson or activity and the type of work that the student(s) did.

3. Have you created or used any lessons or activities that led the students to an understanding or concern about morality or ethics of a topic? (For example students discussed their personal view about the ethics of stem cell research.)

   If so, please describe the topic or activity and how students responded about the morals or ethics of the topic.

4. Have you observed an activity in which a student was prompted to talk about or express a value, faith, or religious belief? (For example in the study of origins of the universe a student might talk about personal faith in creation.)

   If so, what was the lesson, and how did the student respond?

Thank you very much for your participation in this survey. I value your observations.

Bette Grauer
785-532-5592
grauerb@ksu.edu

Appendix B - Semi-Structured Interview

Project: Science Teachers' Use the Affective Domain in Science Education

Time of interview:

Date:

Place:

Interviewer:

Interviewee:

Content area:

Demographic information:

Teacher's gender, age:

Years of teaching experience:

School size, ethnic groups:

Notes:

Questions

1. Have you observed your students' attitude toward work on a science lesson or activity change from compliance to willingness to learn?
   What was the lesson or activity in which the change took place?

   a. What type of behavior did you notice initially?
      i. (Prompt) Did the students exhibit willingness to comply with your request?
      ii. (Prompt) Did the students understand your requirements or objectives (what you wanted them to do)?
      iii. (Prompt) Were the students aware of the science patterns, properties, or principles of the topic?

   b. Over time did you notice behavior changing from compliance to willingness to learn?
      i. (Prompt) Did you notice students developed appreciation for the requirements?
      ii. (Prompt) Did students appear to become intrigued with the topic?
      iii. (Prompt) Did students develop a preference for specific parts of the topic?

   c. Did you notice you no longer needed to pressure students to complete their work?
   d. Approximately how long did it take for the change to occur? (One class period? A period of days?)
   e. What happened to cause the change?
   f. What other new behavior did you notice?
      i. (Prompt) Did you notice that students showed excitement or thrill at an activity or lesson?
      ii. (Prompt) Would you describe your students' behavior as indicating enjoyment?
      iii. (Prompt) Did the behavior indicate satisfaction at an accomplishment?
   g. What lesson progression accompanied this change?

2. Have you created or used any lessons in which the students indicated a recognition or acceptance of the need and value of the topic (or of learning about the topic)?

   a. If so, what was the topic or activity?
   b. What was the behavior?
      i. (Prompt) Did students express satisfaction in learning about the topic?
      ii. (Prompt) Did students indicate a desire to learn more?
      iii. (Prompt) Did students apply or recognize the value of the topic in their personal life, health, or development?

iv. (Prompt) Did students work or invest time on the topic outside class? (beyond homework)
v. (Prompt) Did students continue to recognize the value of a topic throughout succeeding lessons or activities?
vi. (Prompt) Did students develop strong feelings about a topic and openly display those feelings to others?
vii. (Prompt) Did students talk to others about the topic with intent to explain, persuade, or convince?

3. Have you created or used any lessons in which the students discussed the relationship between science and religion, or had concerns about the impact of the topic on their religious views?

   a. If so, please describe the topic and the lesson or activity.
      i. (Prompt) Evolution? Origin of the universe? Geological time?

   b. What types of behavioral responses did you notice?
      i. (Prompt) Were the students firm about their position on the topic?
      ii. (Prompt) Were the students willing to make comparisons or recognize degrees of application? (i.e. macro vs. micro evolution)
      iii. (Prompt) Were the students able to evaluate or compare the topics with regard to their religious views or beliefs?
      iv. (Prompt) Did the students indicate that the topic affected, strengthened, or was in conflict with their value system or religious values?
      v. (Prompt) Did the students understand that the topic affects more than just self? i.e. society, other people, or government policy
      vi. (Prompt) Were the students able to explain or talk about how the topic affected other peoples' lives? i.e. health, family, work
      vii. (Prompt) Did the students understand that the topic related or influenced multiple values? i.e. personal, societal, religious, family

   c. Did you notice a change in your students' attitude over time?

   d. What type of lesson progression accompanied this change?
      i. (Prompt) Did the students progress from being firm on a position about the topic to being willing to consider different aspects of how the topic relates to their beliefs?

4. Have you noticed your students begin to change from a tendency to be judgmental about a science topic to being more objective and logical about a topic or tolerant of views different than their own?

   a. If so, what behavior or statements have you noticed?
      i. (Prompt) Did students progress from being firm on a position about the topic to being willing to consider different aspects of how the topic relates to their beliefs?

ii. (Prompt) Did students change their mind on controversial topics when the facts called for it?
iii. (Prompt) Did students exhibit a willingness to face facts or conclusions that they may not have agreed with?
iv. (Prompt) Did students view problems or disagreements in an objective and tolerant way?
v. (Prompt) Did students approach problems or challenges objectively?

b. What do you believe caused the move toward objectivity or tolerance of views different from their own?

5. Have you noticed that your students have a consistent value system?

a. If so, what were the topics of study or the activities when you noticed this behavior?

b. What behavior did you notice?
i. (Prompt) Did students consistently exhibit honesty and/or integrity?
ii. (Prompt) Did students exhibit a conscience?
iii. (Prompt) Were students concerned with the welfare of others?
iv. (Prompt) In planning or selecting a career path, did students demonstrate a need to find a way to help others?

Notes:

Appendix C - Classroom Observation Sample

Classroom Observation

_____
Biology
10:35 – 11:55am
_____ School

10:35am
Students enter all get out notebooks. Sit at desks, talking to each other. Desks are grouped in sets of 4. 22 students, 10 male, 12 female. (Demographics removed for privacy.)
Some students are looking at jars on cabinets by window. Jars are filled with green water full of algae (?), sticks, small fish. Students are writing in notebooks.

T appears to be taking role, asks what everyone did over spring break. Groups talking to each other about spring break. Lots of talking, teacher moves around room. One student went to Las Vegas.

T: Anybody else? Las Vegas!
Students contribute. Lots of talking.

10:45

T: Get out human inheritance notes, highlighter, pencil pen. I will be around asking what you have added to your notes. Every time you pull out your notes impresses in your brains.
Look over blood types. Look over x linked traits.

T walks around room talking to each group. Some of the conversation is about the notes, other is about other items. Not all conversation is about the lesson. Students are laughing and talking to each other. Students are writing in notebooks and sharing with each other.

T gets handouts, gives a set to each table. Two articles. Both articles are short. Tells students to read and talk about articles. Students read, start talking in groups. T keeps moving about room talking to each group. Some talk is about articles, some outside of lesson.

11:00
Explains direction for large group discussion. Students will be in two large groups.
T: If you have 'article 1', meet here at table. If you have 'article 2', meet by front door. Group must come up with response. Every one write it in notebook. If you don't understand something, raise your hand.

Groups are talking to each other. Very animated. Lots of arguing and trying to persuade. Articles seem controversial. Teacher moves around students working with them on their description/response.

T: What have you got? Do you all have it written down? _____ what did you write?

Teacher asks more questions. Lots of talking among students. Noisy.

11:15
T: Finish summary. One S will talk for group
T divides class into two groups. Students discuss article then present to rest of class. One student explains article and what the group thought about it.

11:35
T shows slides and asks questions
T: Moving on to human genetics.
T has more information.
T: Genetic disorder is an abnormal condition that someone inherits. Is this nature or nurture?

S: Nature

T: Genetic diseases are nature. Have these from birth. Mutations passed down from the parents.

Student asks a question about writing notes. Students are taking notes from slides. Teacher allows time for notes.

Teacher continues discussion:

T: How many pairs of chromosomes?

S: 23?

T: That's right we have 23. Which determine sex?

S: 23rd

T: Been talking about genetic disorders

T: CF, Chromosome number 7 is missing 3 DNA bases. Remember how the bases line up?
Airways unable transport. airways coated with mucus. Person constantly coughing.
No cure. Drugs to help stop infection. Expensive. Physical therapy is daily.
Used to be cf died before their teens. Today, cf are living longer.

T: Sickle cell anemia: Abnormal hemoglobin. A protein in our blood.
Shows normal red blood cell, sickle cell red blood cell. What is the main symptom?

Students respond

T: yes. 9 % of AA carry this gene.

Teacher tells class to put notebooks away, gives directions for previous homework due tomorrow.
11:55 Class ends.

Follow up:

Lesson:
Class had been studying DNA and inheritance. Had been taking notes each day. Today was discussion on two articles on inheritance ethics. ‘

Discussion:
Teacher likes to start by talking about what they have been doing, get them going, then move into lesson. This was first week after spring break, he talked about spring break to get conversation started, then moved to lesson. Lesson included small group discussion, followed by large group discussion. Part of the discussion was informal, lots of talking. He likes to let them talk. When they take notes or get new information, he leads discussion.

Notes:
Classroom has science lab tables and counters on perimeter surrounding student desks. Desks are arranged together in groups of four students facing each other. Demo table, screen located in front of room. Teacher desk located back of room.

Class started with very informal talk while teacher was at desk. Teacher talked to students about lesson and events outside of class. Students have relaxed posture, smiling, laughing. Talking to each other. Some not paying attention to the rest of the class.

Teacher continually moved around room during small group discussion.
In large group presentation, groups were on opposite sides of room, Teacher in middle.
During lesson discussion on DNA, teacher was at front of room with slides.
Students were polite and attentive, serious.

It appeared students were used the class routine, group discussions.

Appendix D - Institutional Review Board Approval

KANSAS STATE UNIVERSITY | University Research Compliance Office

TO: Michael Perl
Curriculum & Instruction
261 Bluemont

Proposal Number: 6485

FROM: Rick Scheidt, Chair
Committee on Research Involving Human Subjects

DATE: 12/06/2012

RE: Proposal Entitled, "Science Teachers' Use of Affective Domain in the Science Classroom"

The Committee on Research Involving Human Subjects / Institutional Review Board (IRB) for Kansas State University has reviewed the proposal identified above and has determined that it is EXEMPT from further IRB review. This exemption applies only to the proposal - as written – and currently on file with the IRB. Any change potentially affecting human subjects must be approved by the IRB prior to implementation and may disqualify the proposal from exemption.

Based upon information provided to the IRB, this activity is exempt under the criteria set forth in the Federal Policy for the Protection of Human Subjects, **45 CFR §46.101, paragraph b, category: 1, subsection: ii.**

Certain research is exempt from the requirements of HHS/OHRP regulations. A determination that research is exempt does not imply that investigators have no ethical responsibilities to subjects in such research; it means only that the regulatory requirements related to IRB review, informed consent, and assurance of compliance do not apply to the research.

Any unanticipated problems involving risk to subjects or to others must be reported immediately to the Chair of the Committee on Research Involving Human Subjects, the University Research Compliance Office, and if the subjects are KSU students, to the Director of the Student Health Center.

203 Fairchild Hall, Lower Mezzanine, Manhattan, KS 66506-1103 | (785) 532-3224 | fax: (785) 532-3278 | k-state.edu/research/comply

Appendix E - Invitation Letter

Date

Dear _____,

I am working on a project to investigate science teacher reports of affective responses in the science classroom. Affective responses are behavioral and/or verbal responses that indicate emotion, feeling, or degree of acceptance or rejection. You have been invited to participate in this project because you completed the Secondary Science Education program at Kansas State University. I believe you have unique and valuable experiences that will contribute to the results of this study.

This project is a research study and the results will be reported in my doctoral dissertation. The purpose of this study is to determine the responses, interactions, and strategies that secondary science teachers report when affective responses emerge in the classroom. The study will examine attitudes, interests, and values reported by science teachers. The intended benefit is the dissemination of information that will contribute to science education pedagogy and practices.

The expected duration of your participation is a maximum of two hours over a period of two months. Data will be collected using an interview, observation of your classroom practices, and student work samples. You may decline to answer any questions and discontinue the interview at any time. You may withdraw consent to participate at any time with no repercussions. If a classroom observation is useful in illuminating or clarifying any of the data, I will request permission to visit. However, you may decline this request. There are no foreseeable risks to you. Your identity will not be disclosed or associated with your responses in any way. All data will be locked and secured for a period of three years and will be destroyed after that time period. You may read the results of your interview and are invited to comment, clarify or correct any information from the interview. You may withdraw from participation at any time.

If you have any concerns or questions, please contact me at any time at:

Bette Grauer
1042 Rathbone Hall
College of Engineering
Kansas State University
Manhattan, KS 66506
grauerb@ksu.edu
785-532-5592
620-245-6545 (cell)

You may also contact the following:

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Rick Scheidt
Chair
Research Compliance Committee
203 Fairchild Hall
Kansas State University
Manhattan, KS 66506
Phone: (785) 532-1483
rscheidt@ksu.edu

I greatly appreciate your responses to my questions, and I promise to be respectful of your time. I believe the results of this study will provide valuable information for science education.

Thank you again for your participation in this research project.

Sincerely,

Bette Grauer
Doctoral Candidate
1042 Rathbone Hall
College of Engineering
Kansas State University
Manhattan, KS 66506

By signing this consent form, I indicate my consent to participate in this research study.

_____
Signature
Date

_____
Bette Grauer
Date

Appendix F - Permission from Publisher

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Upper Saddle River, NJ 07458
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Vineta.Lewis@Pearson.com

Oct 28, 2013

PE Ref # 180784

Bette Grauer, PE
KANSAS STATE UNIVERSITY
1042 Rathbone Hall
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Manhattan, KS 66506-5201

Fax #: 785-532-7810

Dear Profesor Bette Grauer, PE:

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