EVALUATION OF STUDENT ATTITUDE TOWARD SCIENCE AND SELF-EFFICACY IN A NON-MAJORS COLLEGE BIOLOGY COURSE

by

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Introduction and Overview

Educators have long regarded scientific literacy, which characterizes an individual who has a working knowledge of science, as a primary goal for the K-16 population of students. In the past two decades, research literature on the subject has ballooned. In fact, according to Roberts (2007), the two words, *scientific literacy*, are probably the most commonly used terms in science education today. The focus on scientific literacy, at least in part, to the increased demand for scientifically literate people in the workplace, estimating that more than 80 percent of all jobs require proficiency in science (Sprung, 1996).

Educators recognize that scientific literacy involves more than student knowledge about science; it is also affected by a student's attitude and self-efficacy. Both self-efficacy and attitude contribute to how well a student performs in a science class (Dalgety, Coll & Jones, 2003; George, 2000) while other research has noted the role of prior learning and its impact on achievement as well as attitude (Wandersee, Mintzes, & Novak, 1994). In addition, students often base their attitude in subjects such as biology upon past exposure to the subject and the student's positive or negative self-ability assessment, which is also based upon prior experience (Baldwin, Ebert-May, and Burns, 1999).

To gain a better understanding of student attitude and self-efficacy, this researcher conducted a study of non-majors biology students in an urban university in North Texas. The students who participated in this study completed the Attitudes Toward Science Inventory (ATSI) aimed at evaluating attitudes toward science and the Biology Self-Efficacy Scale (BSES) aimed at analyzing student self-efficacy in biology.

Science education literature has well documented student attitudes toward science (Arambula-Greenfield, 1997; Farenga & Joyce, 1999; Freedman, 1997; George, 2000; Glynn, Taasoobshirazi, & Brickman, 2007; Jones, Howe & Rua, 2000; Koballa & Crawley, 1985; Osbourne, Simon & Collins, 2003; Ramsden, 1998; Shrigley, Koballa, Jr. & Simpson, 1988; Siegel & Ranney, 2003; Simpson & Oliver, 1990; Zacharia & Burton, 2004). However, findings have been somewhat mixed (Gogolin & Swartz, 1999). Some studies have revealed that the kind of science teaching students experience affects their attitudes toward the subject (Adams, Perkins, Dubson, Finkelstein, & Wieman, 2005; Ebenezer & Zoller 1993; Perkins, Adams, Pollock, Finkelstein, & Wieman, 2005; Sundberg, Dini, & Li, 1994), but sometimes, even with the use of innovative instructional strategies, student attitudes and subsequent achievements do not necessarily improve (George, 2000; Glynn et al., 2007; Gogolin & Swartz, 1992; Simpson, Koballa Jr., Oliver, & Crawley, 1994; Steinkamp & Maehr, 1983; Willson, Ackerman, & Malove, 2000; Zacharia & Burton, 2004). At the college level, student interest and attitudes toward science may account for as much as 25% of the variability in academic achievement in the subject (Simpson, 1978). In addition, undergraduate science courses foster greater knowledge and awareness among students (Thompson & Mintzes, 2002). Those attitudinal studies involving undergraduate students both majoring in science (i.e., biology) and those not majoring in science have shown that majors students have a more positive attitude toward science than non-majors (Gogolin & Swartz, 1992) while non-majors exhibit a greater variability in attitude (Baldwin et al., 1999). A study by Sundberg, Dini, and Li (1994) detected a shift in student attitude during the course of the semester. Science majors displayed significantly more positive attitudes toward science at the beginning of the class than at the end, but non-majors' attitudes were just the opposite and their attitudes improved over time.

George (2000) has indicated in his work that science self-concept, or self-efficacy, is the strongest predictor of attitudes toward science. However, educational research has not fully explored the relationship between self-efficacy and attitude among students in non-science major courses, such as biology, although several studies have focused on introductory-level chemistry content (Dalgety et al., 2003). Since both attitude and self-efficacy are important contributors to the development of scientific literacy in students, the topics and respective association warrant further investigation.

Review of Literature

Attitude toward Science

The concept of attitude and the associated effects on learning has been a topic of concern and discussion in educational circles for years, yet attitude research remains relatively new on the educational research timeline. It formally began in the 1920s when Thurstone declared in an article that attitudes were measurable (Simpson, et al., 1994). By the 1960s and 1970s, attitudinal research had greatly increased, with a focus in one of three areas: measurement of student attitudes; measurement of change in student attitudes following various treatment methods; and identification of relationships in support of student attitude and science-related behaviors (Simpson et al., 1994). Researchers in the late 1970s and early 1980s regarded attitudes as "both the facilitators and products of science learning and research efforts focused on documenting student attitudes and their relationship to science achievement" (Koballa & Glynn, 2007, p. 77). By the 1990s, attitudinal research began to lag somewhat because there appeared to be no real direction or results provided for improving classroom practice. The last decade has experienced tremendous growth and expansion in science education and corresponding research into "student attitudes and beliefs that shape and are shaped by student classroom experience" (Adams et al., 2006, p. 1). Part of this growth in attitudinal research may be due, in part, to the steady decline in the number of students in the scientific career pipeline (Osborne, 2003). The drop has been large enough to cause concern among educators, and, at the same time, warrant closer examination by researchers. As a result, attitudes and beliefs of students has become one of the targeted areas of study because researchers have demonstrated that they play a role in how students benefit from their academic experiences (Redish, Saul, & Steinberg, 1998). The research of Simpson et al. (1994), Weinburgh (2000), and Thompson and Mintzes (2002) stated that attitudes are not reflections of what humans are pre-thought or predisposed to do, but that attitudes are inferred from behaviors. However, Simpson et al. (1994) discussed prior knowledge as a predisposition gleaned from the initial opinion the person developed. According to Baldwin et al. (1999), prior knowledge and experience shape the learning process, which in turn affects a student's attitude.

In past research studies have shown that the classroom environment and home environment impact attitudes toward science. Simpson and Oliver (1990) found high relationships between student self, school, family, and attitude. Researchers have found a connection between homes with high amounts of parent involvement and high science attitudes and interests in teenagers (Talton & Simpson, 1986). Likewise, Ebenezer and Zoller (1993) found that students like to take an active part in their science learning, preferring classes with more hands-on opportunities rather than a completely lecture-oriented classroom. Although it was necessary to report on the research literature regarding the impact of the classroom and home environments on attitude, it must also be noted that this was not a focus of the current study, but certainly important research that cannot be disregarded, particularly since the teaching environment in this study was the same for all student participants.

Other attitudinal research has focused on gender and related issues. Simpson et al. (1994) reported that gender is one of the most significant factors related to student attitudes toward science. Cannon and Simpson (1985) and Weinburgh (2000) researched gender, as did Simpson and Oliver in 1990. In 1985, Cannon and Simpson found that gender was not a significant factor in determining student attitude. The Simpson and Oliver study (1990) found that gender is not as significant a factor as they had expected, although males exhibited more positive attitudes toward science and females were more motivated to achieve in science. However, Weinburgh's study (2000) concluded that gender is significant when predicting student attitudes toward the teacher and enjoyment of science. Both grade level and ethnicity proved to be significant predictors for five of the six ATSI scales (Weinburgh, 2000). While the research literature has demonstrated the importance of gender on attitude, this study focused upon the relationship that exists between student attitude and self-efficacy.

At this point, it is important to differentiate between attitudes towards science and scientific attitudes (Gogolin & Swartz, 1992; Moore & Foy, 1997; Simpson et al., 1994). Scientific attitudes are "ways in which scientists believe in and conduct their work" (Simpson et al., 1994, p. 212). Attitudes toward science represent "a person's positive or negative response to the enterprise of science. Put another way, they refer specifically to whether a person likes or dislikes science" (Simpson et al., 1994, p. 213). The focus of this study is not toward scientific attitudes but on the attitudes toward science. Only a few attitude inventories have focused specifically on the life sciences and college students' attitudes or perceptions toward the subject (Dalgety et al., 2003; Gogolin & Swartz, 1992; Kitchen, Reeve, Bell, Sudweeks & Bradshaw, 2007; Weinburgh, 2000). Therefore, the purpose of discussion in this paper, "science attitude" or "scientific attitude" will refer to an individual's perceptions, thoughts, or motivations to understand science, particularly biology.

Self-Efficacy

In addition to attitude, self-efficacy plays an important role in understanding students and their experiences in learning science. Past studies have examined student self-efficacy and self-learning, particularly focusing on internet self-efficacy (Joo, Bong & Choi, 2000). Results have shown that students' academic self-efficacy predict their performance on the given written test (Joo et al., 2000). Another focus of past self-efficacy studies has been its relationship to self-concept, a term many have often confused with self-efficacy. Bong and Skaalvik (2003) studied self-efficacy and its relationship to self-concept. They concluded that self-concept primarily relates to an individual's total thoughts about him or herself as an object while self-efficacy represents what an individual perceives about his/her own abilities and skills (Bong & Skaalvik, 2003). Also, researchers have studied self-efficacy in conjunction with the psychology of motivation (Glynn et al., 2007; Zimmerman, Bandura & Martinez-Pons, 1992) and the psychosocial role (Bandura, Caprara, Barbaranelli, Gerbino, & Pastorelli, 2003).

Relative to the life sciences, researchers have not commonly studied self-efficacy. One project explored self-efficacy among biology non-majors (Baldwin et al., 1999). However, there was no discussion of any relationship that might exist between self-efficacy and science attitude, although the same researchers noted that self-efficacy and attitude may affect a student's desire to become scientifically literate (Baldwin et al., 1999).

The value of self-efficacy lies in the students' evaluation of their own views, the effectiveness of teaching and learning strategies, and the development of a higher self-reported confidence in understanding and using biology. Students' learning experiences affect those students' enrollment choices (Farenga & Joyce, 1999). For example, students' apprehensions about the amount of coursework and homework involved in studying high level science will influence their enrollment choices (Dalgety et al., 2003). According to Bloom (1976), twenty-five percent of achievement may result from how students feel about science and their concept of self. Zeldin, Britner, and Pajares (2007) state that people are more likely to perform well in tasks they feel they can be successful, and they will be more likely to have higher self-efficacy when they have successful experiences. The research of Oliver and Simpson (1988) and Mitchell and Simpson (1982) has also connected self-concept and achievement.

Student interest also plays a part in the classes in which they enroll; the majority of students enrolled in science courses are interested in science enough to major in it (Dalgety et al., 2003; Farenga & Joyce, 1999; Zeldin et al., 2007). Other factors that affect self-efficacy include the role of prior experiences in performing a similar behavior; providing the students with opportunities to observe others performing the behavior (the positive attitude); and the self-perceived level of physiological cues (Baldwin et al., 1999; Bandura, 1986).

Due to the emphasis on feelings and beliefs, researchers consider attitude and self-efficacy an integral part of the affective domain. Attitude relates to feelings; it is how students feel about biology, positively or negatively. Self-efficacy involves student beliefs about how "good" or "bad" they are in a particular subject. Students consider beliefs as "truths" (Baldwin et al., 1999). Baldwin et al. (1999) have stated the following about the relationship between belief, attitude, and behavior: "[I]f a college student judges his/her ability to be lacking in science (belief), that lack in confidence may lead to a dislike for science (attitude) and to a subsequent avoidance of science education (behavior)" (p. 398). Self-beliefs about abilities greatly influence the way students behave and determine many of the students' choices throughout their time in school. These choices concern the amount of effort students will give in the completion of complex tasks, how much time they will devote to a course, and how persistent they will be when faced with any learning obstacles (Baldwin et al., 1999). Bong and Skaalvik (2003) have reported that the ability to monitor one's own learning influences individual feelings about self-efficacy. Learning is essential and does not necessarily involve a change in behavior, but learning instead leads to a "change in the meaning of experience" (Novak & Gowin, 1984). Regarding the connection between learning and self-efficacy, they have written the following:

> We have expected [teachers] to cause learning in students, when of course, learning must be caused by the learner. We have found repeatedly in our research studies that educational practices that do not lead learners to grasp the meaning of the learning task usually fail to give them confidence in their abilities and do nothing to enhance their sense of mastery over events.(Novak & Gowan, 1984, p. xii)

Other studies have also demonstrated that students who have a better understanding of their content knowledge will have improved biological literacy, and they will feel more confident in the life sciences as well as other sciences (Koballa, Kemp & Evans, 1997; Simpson et al., 1994; Uno & Bybee, 1994).

Survey Instruments

Several existing tests, such as the Scientific Attitude Inventory (SAI), the Scientific Attitude Inventory II (SAI2) and the Test of Science Related Attitudes (TOSRA) evaluate scientific attitudes and attitudes towards science (Moore & Foy, 1997; Dalgety et al., 2003). However, the SAI and SAI2 do not measure attitudes towards science; they measure scientific attitudes. Furthermore, the TOSRA tests for scientific knowledge for a group with little scientific knowledge, and the level and language of the test would be too simplistic in nature for a college level course (Dalgety et al., 2003). Dalgety et al. (2003) created an attitudinal instrument that also measured self-efficacy; however, this instrument was completely chemistry oriented and not appropriate for an evaluation of biology attitudes and self-efficacy.

According to Baldwin et al. (1999), the Biology Self-Efficacy Scale is a valid and reliable tool for studying non-biology majors' confidence levels in the mastery of biological literacy. This scale, developed by Baldwin et al. and introduced in their 1999 paper, is a predictor of the necessary change processes important in the improvement of students' biology achievement, and is therefore an essential tool in a self-efficacy study.

This instrument may lead to further understanding of student behavior, which can, in turn, increase students' desire to understand and study biology. Furthermore, by gaining insight into their students' biology self-efficacy, the instructors will be able to notice a rise or fall in students' confidence levels as they engage in more complex tasks during the life of the course (Baldwin et al., 1999). Also, instructors then have more ways of identifying the type of professional development that would enhance their teaching.

Scientific Literacy

A major goal in researching attitudes and self-efficacy in the sciences (i.e., biology) is to produce scientifically literate citizens. Scientific literacy is the knowledge of major scientific topics and constructs, along with the understanding of the norms of science (Koshland, 1985; McEneaney, 2003; Simpson et al., 1994; Uno & Bybee, 1994; Zacharia & Burton, 2004). Biological literacy is scientific literacy, which specifies understanding biological topics, methods of biology, the basics of biology and other science courses, and applying biological concepts and skills (Baldwin et al., 1999; Koballa et al., 1997; McEneaney, 2003; Rutherford & Ahlgren, 1990). Science illiteracy frequently results from insufficient exposure to and/or experiences in science (Cobern, Gibson & Underwood, 1995; Crawley & Koballa, 1994; Gogolin & Swartz, 1992; Koballa et al., 1997; Koshland, 1985; Uno & Bybee, 1994). The majority of college students in America receive only limited exposure to introductory-level science courses (Cobern et al., 1995; Gogolin & Swartz, 1992; Koballa et al., 1997; Tobias, 1990). Unfortunately, for many students, learning science involves negative attitudes and feelings, which discourage further pursuit of scientific inquiry (Gogolin & Swartz, 1992). Instruction, in its most effective form, would produce students who understand scientific constructs, the scientific approach to information and science policy issues, and who will act upon their civil responsibilities (Simpson et al., 1994). The acquisition of knowledge enables students to raise their own understanding and literacy level (Koballa et al., 1997; Simpson et al., 1994; Uno & Bybee, 1994).

Definition of Terms

Over the years, several definitions of the term “attitude” have developed. Thompson and Mintzes (2002) defined attitude as "a tendency or state internal to a person which biases or predisposes a person toward evaluative responses which are to some degree favorable or unfavorable” (p. 646). Simpson et al. (1994) defined attitude as “a predisposition to respond positively or negatively to things, people, places, events or ideas. [W]e have attitudes toward such objects as ‘teacher,’ ‘mathematics,’ or ‘school’” (p. 212). Baldwin et al. (1999) viewed attitude as the positive and negative feelings toward something. This study defines attitude as a positive or negative opinion towards a specific subject, whether the student has prior experience with that subject or not.

As with attitude, researchers developed a myriad of self-efficacy definitions for “self-efficacy.” Dalgety et al. (2003) defined self-efficacy as a student’s perception of his or her ability to undertake a specific scientific task or tasks. Simpson et al. (1994) defined self-efficacy as students’ perceptions of their own ability, the barriers they might come against, the resources the school or college should provide them, and the opportunities they have regarding their actions related to the information they have received. For the purpose of this study, self-efficacy is defined as the students’ perception of their own ability based on prior experience, whether personal or gathered from others, with a specific topic or task.

Purpose

This study investigated the relationship and effects of self-efficacy and attitude of non-major science students enrolled in an introductory biology course. The questions posed for this research include the following: (a) What attitudes and self-efficacy feelings do non-major biology students have toward biology?; (b) Will the attitudes and self-efficacy feelings change with instruction?; and (c) Is there a correlation between attitude and self-efficacy?

Method

This study examines student attitudes and self-efficacy in a contemporary issues biology course at an urban, private university in North Texas. The introductory course, specifically designed for non-science majors, fulfils university requirements for science credit. Most students in the course register as freshmen or sophomores. A combined survey of a science attitudes survey and a self-efficacy survey was administered at the beginning of the semester, then again after 10 weeks of instruction. This researcher evaluated the pre-instruction survey and post-instruction survey using descriptive statistics, processed in factor analysis and compared using a paired samples t-tests, and the correlation between attitude and self-efficacy utilized Pearson's r as its correlation coefficient.

Subjects

The researcher conducted statistical analysis on 128 student participants who completed both pre- and mid-course surveys, and whose responses could be matched. Demographic data on participants consisted of the following: 68 % female, 32 % male, 5% African American, 83 % Caucasian, 1% Asian American, 7% Hispanic, 4% Multi-Racial and 0% Other. All participants were students of the same professor. Participation in this study was strictly voluntary and not a requirement of the course.

Instruments

After reviewing the literature, the researcher determined that the most appropriate evaluative instruments for the purpose of this study are the Attitudes Toward Science Inventory and the Biology Self-Efficacy Scale. The Attitudes Toward Science Inventory exists in many forms and scales. The format used for this study is the five-point Likert Scale format with the normal 48 questions; demographic questions regarded only gender and ethnicity. The initial self-efficacy instrument developed by Baldwin et al.(1999) was distributed to a sample group of non-major college biology students; however, in this study, the researcher slightly modified the instrument, the Biology Self-Efficacy Scale, to fit the confines of the class. Those items which were not addressed in the non-majors biology course were removed from the survey instrument. The survey was administered in conjunction with the attitudinal survey instrument, which was not modified. The intent of the study was to gain a better understanding of factors and influences that affect student attitude and self-efficacy. This information could then be used by the course instructor to develop a variety of instructional methods which would promote scientific literacy.

Using the Attitudes Towards Science Inventory (ATSI) and the Biology Self-Efficacy Scale (BSES) in a combined survey, the researcher requested student input. The self-efficacy survey touched on past and current teaching issues. The pre- (survey 1) and post-instruction (survey 2) surveys both consisted of the same 48-item ATSI and the 17-item BSES.

<u>The Attitude Toward Science Inventory</u>. The ATSI is a 48-item inventory with high construct validity (Gogolin & Swartz, 1992). By nature, this inventory is multidimensional, which is desirable when one assesses multivariate subjects like attitude and self-efficacy (Gogolin & Swartz, 1992). The ATSI contains six scales, with statements involving eight variables: perception of the science teacher, anxiety toward science, value of science in society, self-concept in science, enjoyment of science, and motivation in science. However, this study found only four. The differences were in the anxiety and motivation variables; in this study, “anxiety toward science” and “self-concept of science” collapsed into one variable

and "motivation in science" did not materialize. Like the original ATSI, students responded to the survey using a five-point Likert scale: 1= Strongly Disagree, 2=Disagree, 3=Undecided, 4=Agree, and 5=Strongly Agree with demographic questions involving only gender and ethnicity. No changes were made to the original ATSI for this study. To review the original instrument, refer to Appendix A.

The Biology Self-Efficacy Scale. The BSES is a multi-dimensional construct which contains 23 items and consists of at least three dimensions: the application of biological concepts and skills, methods of biology and generalization to other biology/science courses, and analyzing data (Baldwin et al., 1999). Students answered the BSES on a Likert Scale with 1=Totally Confident, 2=Fairly Confident, 3=Somewhat Confident, 4=Only a Little Confident and 5=Not at All Confident. Baldwin et al. (1999) found a moderate level of correlation between the three subscales, and through factor analysis; the BSES showed that the subscales measured three discrete and homogeneous domains of self-efficacy (Baldwin et al., 1999). The constructs included methods of biology, generalization to other biology/science courses and analyzing data, and application of biological concepts and skills. Although Baldwin et al. (1999) found those three constructs, this study only found one. This study reported only two of the original eight questions from the "methods of biology construct." Consequently the "methods in biology," construct did not form for this administration of the survey. The two variables, "generalization to other biology/science courses and analyzing data" and "application of biological concepts and skills" collapsed into one large self-efficacy variable.

For this study, the researcher reduced the number of questions from 23 to 17, as the additional questions included items that were not a part of the non-majors biology class, and the options for answers were changed to 1=Totally Confident, 2=Somewhat Confident, 3=Undecided, 4=Only a Little Confident and 5=Not at All Confident in order to provide the students with an option for undecided, which better aligned with the options given with the ATSI. The questions removed were the majority (4 out of 6) of the “methods in biology” domain. To review the survey used in this study, refer to Appendix B. To review the BSES before alterations, see Appendix C.

Course Description

For the purpose of this study, those students who participated were enrolled in a non-majors college biology class. The course involved contemporary biology issues as they related to the life sciences including topics ranging from cellular and molecular biology to the ecosystem levels of biological organization. The non-majors biology class included laboratory sections in the biology computer lab as well as traditional laboratory activities.

Procedure

Prior to the first week of class, the professor sent the students information about this study via email and invited them to participate. The email contained a link to Zoomerang, the online survey instrument. Students took both the pre-instruction and the mid-term-instruction surveys using Zoomerang. The first section of the surveys emphasized that the instructor would not know who participates and who does not. Only students checked the “I consent” box could access and complete the survey. The students made their own code using the name of the street on which they lived as a child and on the last four digits of their cell phone numbers.

Questions on the mid-term-instruction survey prompted the students to remember that their code consisted of these two items. After 10 weeks of instruction, the professor sent an email to all students in the class, prompting them to complete the survey again. Once the students completed the survey, the results were eligible for statistical analysis.

Results

Results of this study determined that students have a more positive attitude about science, but they possess less confident feelings of self-efficacy after instruction than they did prior to enrolling in and attending the course. Other findings determined that self-efficacy and attitude correlated with a small, but significant correlation of .23.

Surveys

Due to the combined nature of the survey, the adjustments of the original BSES to better align with class material, and the use of the five-point Likert Scale version of the ATSI, the researcher ran internal consistency reliabilities on both the pre- and post-surveys. Reliability calculations yielded Cronbach's alpha coefficients of .77 to .92 for survey 1 and .72 to .91 for survey 2 (refer Table 1).

Table 1. Reliability results for pre- and post - surveys.

	Survey Reliability Results (Cronbach's α)	
Variable	Survey 1	Survey 2
Science Teacher	0.77	0.81
Anxiety in Science	0.87	0.88
Enjoyment of Science	0.94	0.91
Science in Society	0.77	0.72
Student Self-Efficacy	0.92	0.91

ATSI survey. The pre- (survey 1) and post-instruction (survey 2) surveys both consisted of the 48-item, five-point Likert Scale ATSI with gender and ethnicity demographical questions and the 17-item BSES. Regarding the ATSI survey, factor analysis revealed four clear factor variables with loadings of .5 or higher. Table 2 (following page) lists the four factors (ATSI variables) and the loading range of the associated questions.

The four ATSI variables were classified as: Attitudes toward science teacher; anxiety in science; enjoyment of science; and views of science in society. Three of the four ATSI variables, including attitudes toward science teacher, enjoyment of science, and view of science in society, were increasingly positive graphs demonstrating that attitudes improved over the course of the semester and became more positive. The anxiety in science category decreased between the administration of the pre- and post- surveys. Two additional factors contained weak correlations and low numbers. These factors were not considered complete and were deleted from further analysis due to factor loadings of less than .4.

Table 2. ATSI factor variables and associated questions

Variable	Factor Loading Survey 1,2	Variables Questions
Science Instructor	.679-.782, .737-.790	
		Science teachers show little interest in their students.
		Science teachers present materials in a way that I understand.
		Science teachers do not seem to enjoy teaching science.
		Science teachers are willing to give me individual help.
		Science teachers do not like students to ask questions.
Anxiety in Science	.612-.821, .644-.847	
		No matter how hard I try, I cannot understand science.
		I feel tense or upset when someone talks to me about science.
		I often think, "I cannot do this," when a science assignment seems hard.
		Working with science upsets me.
		It makes me nervous to even think about doing science.
		It scares me to have to take a science class.
		If I do not see how to do a science assignment right away, I never get it.
Enjoyment of Science	.570- .870, .410-.812	
		Science is something that I enjoy very much.
		I do not do very well in science.
		I feel at ease in a science class.
		I would like to do some extra or un-assigned reading in science.
		When I hear the word "science," I have a feeling of dislike.
		I would like to send less time in school studying science.
		Sometimes I read ahead in our science book.
		It does not disturb or upset me to do science assignments.
		I would like a job that does not use any science.
		I enjoy talking to other people about science.
		I enjoy watching a science program on television.
		I like the challenge of science assignments.
		It scares me to have to take a science class. (factored twice)
		The only reason I am taking science is because I have to.
		I have a good feeling toward science.
		Science is one of my favorite subjects.
		I have a real desire to learn science.
Science in Society	.610-.701, .445-.713	
		Science is useful for solving the problems of everyday life.
		There is little need for science in most of today's jobs.
		Most people should study some science.
		Science is of great importance to a country's development.
		It is important to know science in order to get a good job.
		You can get along perfectly well in everyday life without science.
		Most of the ideas in science are not very useful.

As demonstrated in Figure 1, post-survey results of students about the science teacher indicated a significant increase in means from 3.56 to 3.99, t (127) = -6.797,

$p < .0001$. In Figure 2, the mean anxiety significantly decreased from 2.47 to 2.23, t (127) = 5.163, $p < .0001$. Regarding the enjoyment of science variable, the mean significantly increased from 2.89 to 3.18 (Figure 3) and t (127) = -6.904, $p < .0001$. The mean attitude significantly increased from 3.83 to 3.97 (Figure 4) on the science in society variable, t (127) = -3.196, $p < .002$.

Figure 1. Attitudes toward science teacher increased between survey one (GoodTeacher1) and survey 2 (GoodTeacher2).

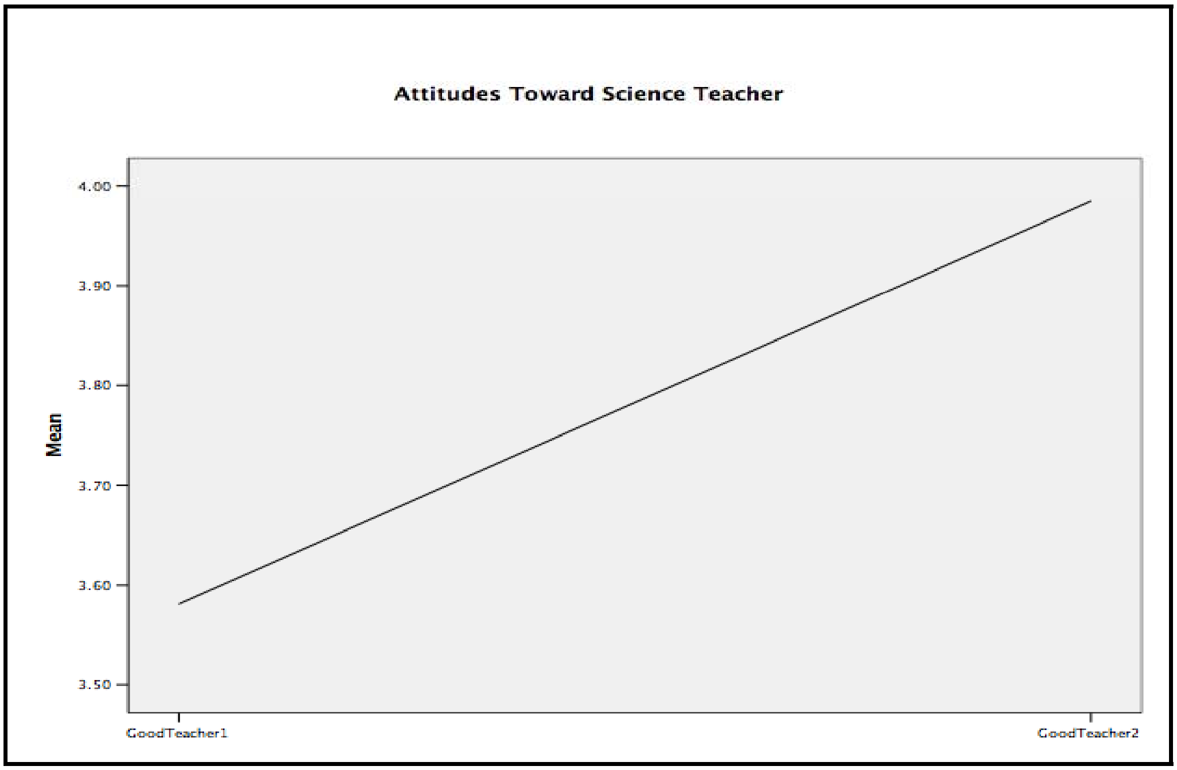


Figure 2. Anxiety in Science decreased between survey one (Anxiety1) and survey two (Anxiety2).

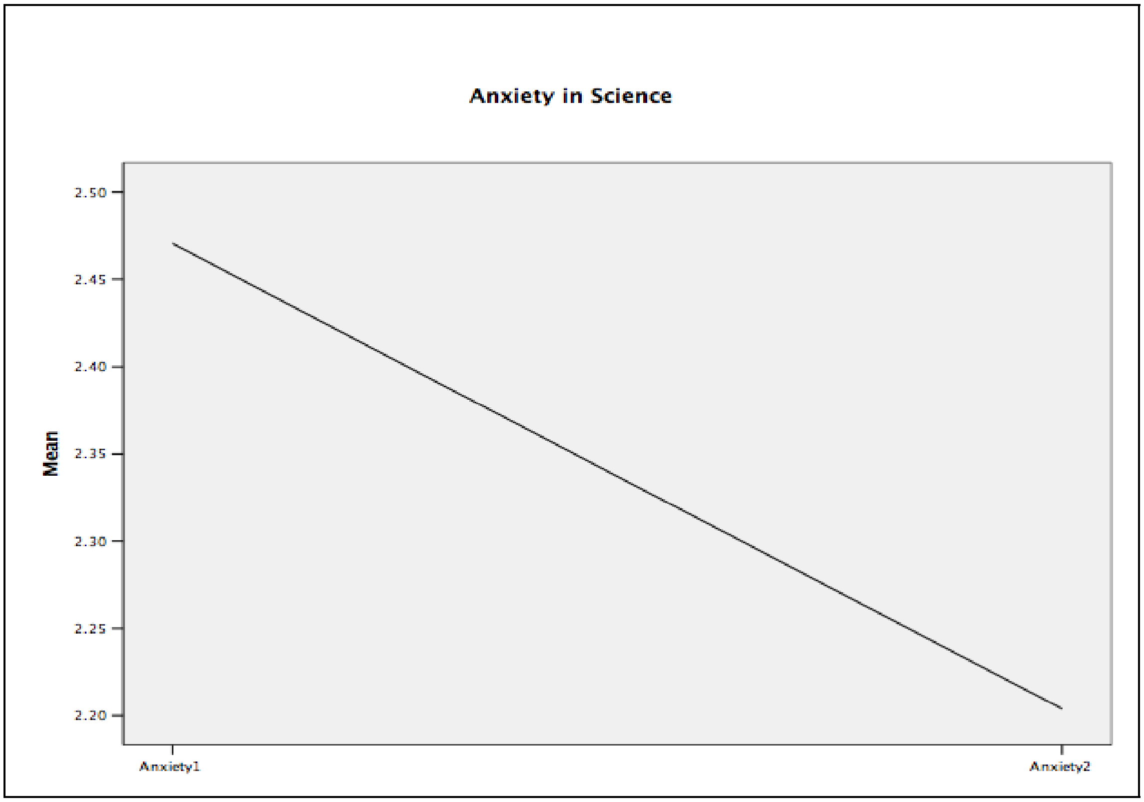


Figure 3. Enjoyment of science increased between survey one (Enjoyment1) and survey two (Enjoyment2).

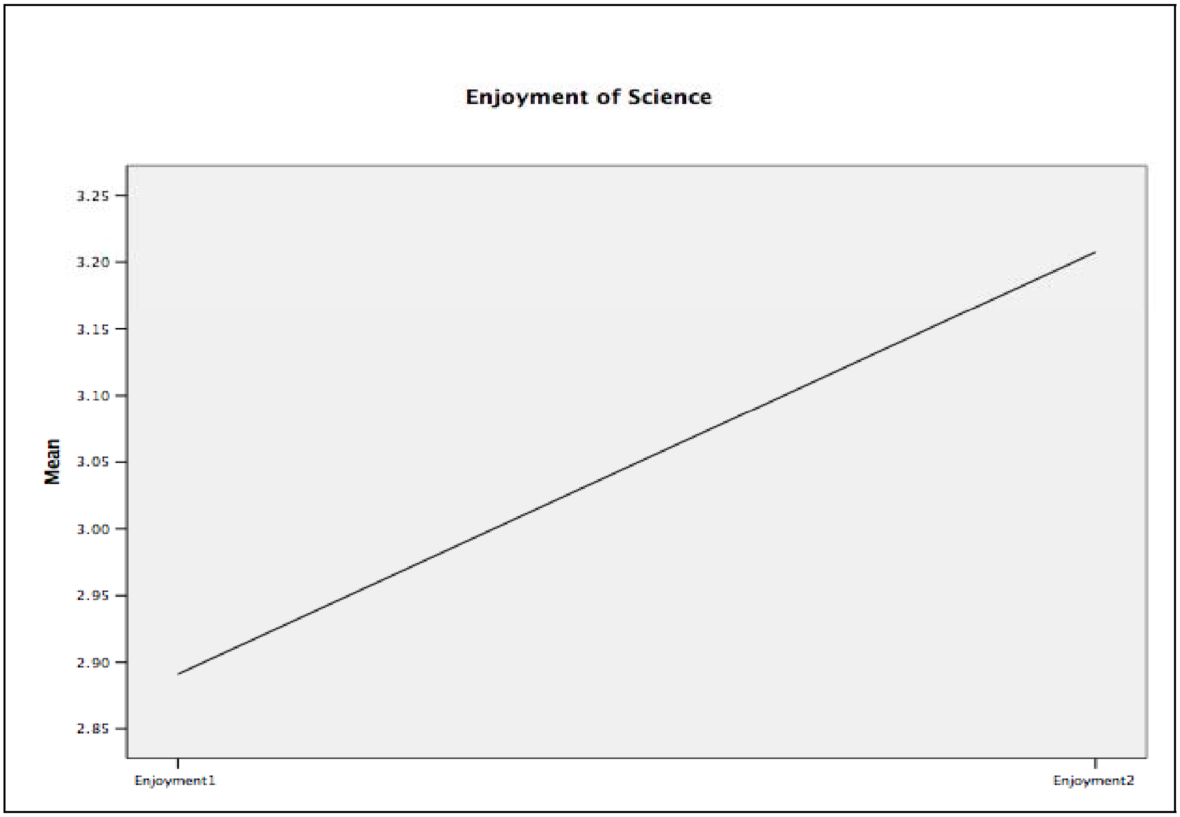
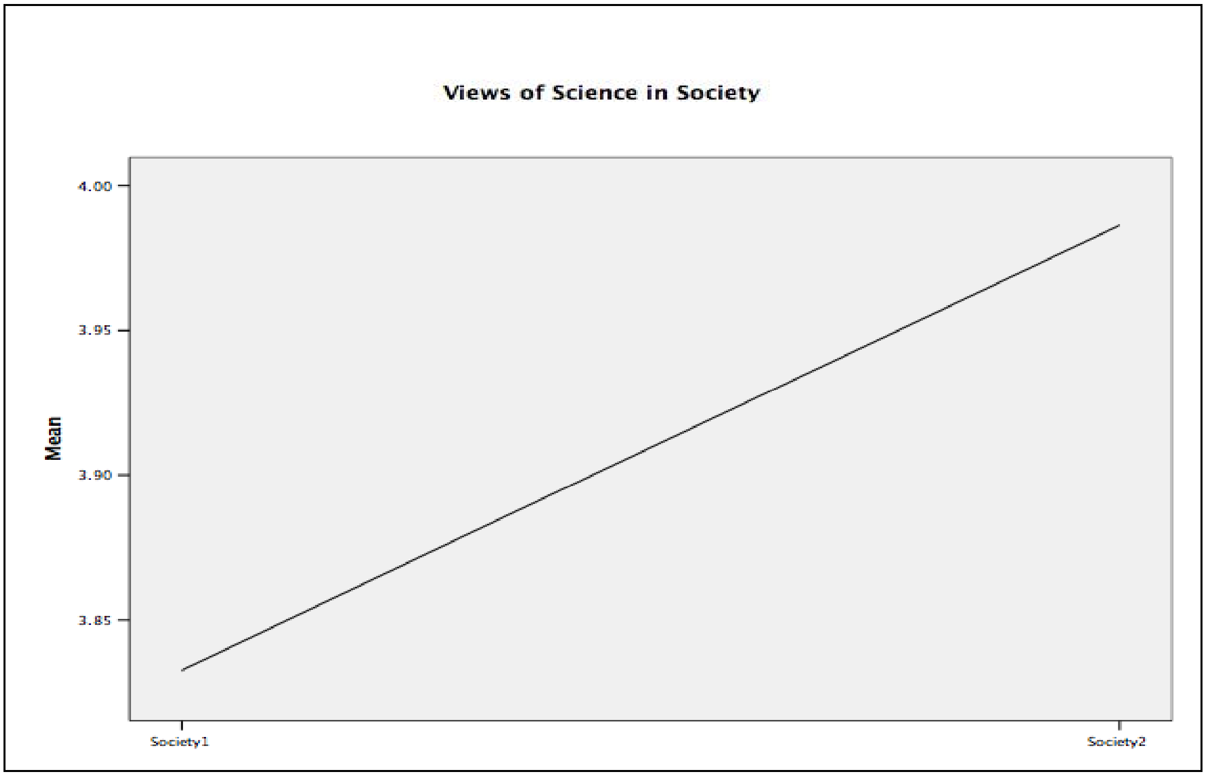


Figure 4. Views of Science in Society increased positively between survey one (Society1) and survey two (Society2).



BSES survey. The BSES items loaded together into one general factor (refer to Table 3). The reduction in number of questions resulted in a deletion of the variable "methods of biology." This deletion caused a collapse of the remaining two dimensions into one comprehensive self-efficacy factor. All items show a significant and positive correlation with moderate to high *r*'s (range= .2 to .7). For the BSES portion of survey 1, the inter-item consistency was strong (Cronbach's α= .92). The mean answer from the BSES was 2.71 for survey 1 and 2.35 for survey 2 (see table 2, graph 5). Attitude significantly correlated with self-efficacy (*r*=.481), indicating a positive correlation. Altogether, self-efficacy correlated significantly with attitude at 23 percent (*r*=.23). In comparing pre- and post- survey responses regarding self-efficacy, the researchers found significance: t (127) = 8.450, p < .0001, with the exception of 'views of science in society," which loaded at p= .02.

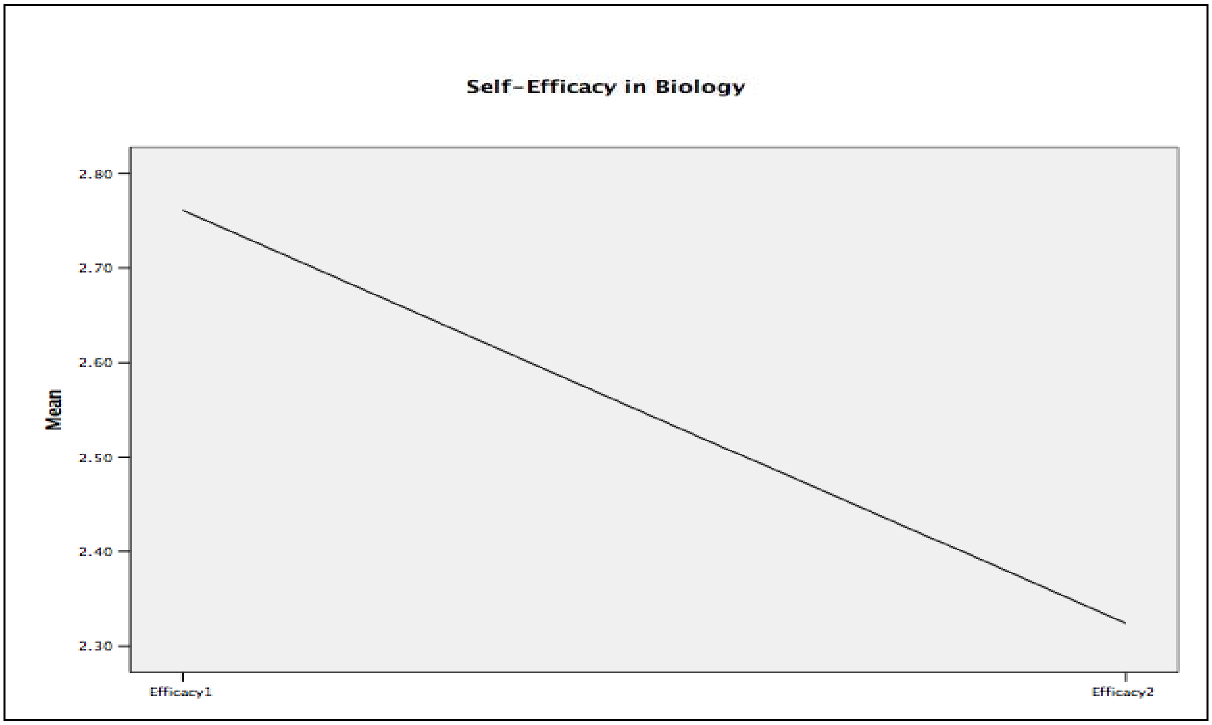
Table 3. Survey 1 & 2 questions on self-efficacy variable and the factor loadings

Name	Factor Loading
Self-Efficacy	.532-.747

Question

How confident are you that after reading an article about a biology experiment, you could write a summary of its main points?
How confident are you that you could critique a laboratory report written by another student?
How confident are you that after reading an article about biology experiment, you could explain its main ideas to another person?
How confident are you that you could read the procedures for an experiment and feel sure about conducting the experiment on your own?
How confident are you that after watching a television documentary dealing with some aspect of biology, you could write a summary of its main points?
How confident are you that you will be successful in this course?
How confident are you that after watching a television documentary dealing with some aspect of biology, you could explain its main ideas to another person?
How confident are you that you will be successful in another biology course?
How confident are you that after listening to a public lecture regarding some biology topic, you could write a summary of its main points?
How confident are you that you would be successful in an ecology course?
How confident are you that after listening to a public lecture regarding some biology topic, you could explain its main ideas to another person?
How confident are you that you would be successful in a human physiology course?
How confident are you that you could critique an experiment described in a biology textbook (i.e. lists the strengths and weaknesses)?
How confident are you that you could tutor another student for this biology course?
How confident are you that you could ask a meaningful question that could be answered experimentally?
How confident are you that you could explain something that you learned in this biology course to another person?
How confident are you that you could use a scientific approach to solve a problem at home?

Figure 5. Self-Efficacy in biology decreased between survey one (Efficacy1) and survey two (Effiacy2).



Results of the paired samples t-test comparisons between the pre-instruction survey and the post-instruction survey indicated that the students experienced an overall significant increase in attitude after instruction (and a decrease in self-efficacy after instruction) (see Table 4).

Table 4. Paired Samples T-test results

		Paired Differences					T	df	Sig. (2-tailed)
		Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference				
					Lower	Upper			
1	GoodTeacher1 - GoodTeacher2	-.40313	.67999	.06010	-.52206	-.28419	-6.707	127	.000
2	Anxiety1 - Anxiety2	.26656	.58405	.05162	.16440	.36871	5.163	127	.000
3	Enjoyment1 - Enjoyment2	-.31646	.51862	.04584	-.40717	-.22575	-6.904	127	.000
4	Society1 - Society2	-.15351	.54336	.04803	-.24854	-.05847	-3.196	127	.002
5	Efficacy1 - Efficacy2	.43652	.58220	.05166	.33428	.53876	8.450	126	.000

Limitations

This study has some limitations. Foremost, a semester (or longer) review on student attitude and self-efficacy might demonstrate some student differences not reflected in the current 10-week study. Also, the number of participants in this study was relatively small. A study at a university with a larger student pool would have provided broader sampling opportunities. Another limiting factor was the use of classes from only one professor. Using classes with different instructors might allow for more diverse results, particularly for the attitude toward teacher variable.

Discussion

In the existing literature, this study appears to be the first to examine a correlation between attitude and self-efficacy for non-majors in a biology class. As this study may be the first of its kind, there is little background literature on which to build, although Bloom's 1976 study did find a 25 percent correlation; it evaluated self-efficacy and achievement, not attitude. This study found that a .23, significant correlation exists between self-efficacy and attitude in biology for non-majors, which suggests that a student's attitude does influence his or her self-efficacy in biology and vice versa. The increase in positive attitudes toward science could be attributed to the quality of instruction or perhaps an increased appreciation for the science material presented and discussed in the class. The decrease in self-efficacy might possibly be attributed to the methods of assessment or the difficulty level of the assessment instruments. Ulber (2003) and Zeldin et al. (2007) determined that self-efficacy should increase with student feelings of success in the classroom experience. Thus, it is possible that students were not feeling "successful" in their course performance when they responded to the self-efficacy survey. Further, Ulber (2003) noted that situatedness, as it relates to relevancy in a real context, influences student self-efficacy and attitude in classroom performance. In her findings, Ulber (2003) has stated that student "attitudes in schools should become more positive as they are affected by the positive and motivating experiences of situated learning" (p. 2).

In recent years, researchers have studied student self-efficacy and attitudes in a variety of disciplines. Zimmerman et al. (1992) and Gogolin and Swartz (1992) studied self-efficacy as it relates to self-motivation, focusing on the factors contributing to student motivation. They discovered that factors such as parental goal setting, self-efficacy and the student's own goals are predictive of the grade the student will receive at the end of the course (Beghetto, 2007; Zimmerman et al., 1992). While their results are important, this study did not evaluate parental goal setting or a student's self-predicted grade.

Another study by Dalgety et al. (2003) researched self-efficacy in relation to enrollment and the college chemistry classroom and compared the self-efficacy and attitudes of non-chemistry majors to those of chemistry majors. The purpose of the study by Dalgety et al. (2003) was to construct a survey instrument for use in the study of attitude and self-efficacy, although they did not actually use the instrument to study self-efficacy and attitude as this study did. Simpson et al. (1994) and Weinburgh (2000) touched on the concept of student enrollment choices in relationship to attitude. They found that students make a judgment after carefully evaluating their options (Simpson et al., 1994; Weinburgh, 2000). However, this study did not evaluate students' enrollment choice as a part of their self-efficacy or attitude.

Zimmerman et al. (1992), Dalgety et al. (2003), and Baldwin et al. (1999) studied student self-efficacy. Their multiple projects were created with a similar goal of this study--to promote scientific literacy. Baldwin's study (1999) developed the BSES instrument and administered it to a population of students similar to those described in this study; however, like Dalgety (2003), she focused on instrument development. As such, the findings of this study appear to offer an additional perspective to those presently in the literature regarding the BSES.

Studies relating the field of biology to attitude and to self-efficacy are few in number. Oliver and Simpson (1988) and Shrigley et al. (1988) showed a high relationship between achievement and self-concept in science; however, they did not find correlations between attitude and self-concept. A cross-age study done by Thompson and Mintzes (2002) developed a questionnaire about sharks, which they gave to students in elementary, middle and high school, along with marine biology majors at the undergraduate level. The positive attitude was related to the additional knowledge the marine biology majors had compared to a lower amount of knowledge as the grades decreased (Thompson and Mintzes, 2003). While this study was not a cross-age study, the results have shown that, after students have achieved a higher level of understanding about science, they do have a more positive attitude towards biology.

In 1992, Gogolin and Swartz completed another study regarding attitude. Gogolin and Swartz used the Attitudes Toward Science Inventory (ATSI) to evaluate student attitudes toward science in a non-majors college biology course and compared them to the attitudes of biology majors. Their study found that the biology majors' enjoyment and value of science decreased during the semester, while the enjoyment and value of science for the non-majors increased after instruction (Gogolin & Swartz, 1992). This study's results for non-majors agree with the results of Gogolin and Swartz (1992).

Conclusion

The findings of this study determined that students exhibited a positive increase in overall attitude toward science. Attitudes toward the science teacher, enjoyment of science and the students' attitudes toward the value of science in society all increased following instruction. Student anxiety toward science decreased significantly after instruction. While the attitudes became increasingly positive, the students' confidence, or self-efficacy, decreased. This decrease in confidence may be due to the assessment procedures of the non-majors biology course.

Additional research is necessary to further the study of improving student attitude toward science and self-efficacy in an effort to promote scientific literacy. Specific research on gender and ethnicity in relation to both attitude and self-efficacy is also desirable. While this study is valuable, there is need for further research. Specifically, continued research in student attitude and self-efficacy in biology for non-majors is an essential component of the improvement of instruction in the life sciences. Osborne (2003) stated that more educational research is needed in the area of student attitudes and perceptions. He wrote:

> For lest it be forgotten, attitudes are enduring while knowledge often has an ephemeral quality. The price of ignoring this simple fact and its implications is the potential alienation of our youth and/or a flight from science – a phenomenon that many countries are experiencing. There can, therefore, hardly be a more urgent agenda for research (2003, p. 1074).

Ultimately, the researcher hopes that insights into attitude and self-efficacy gleaned from this project will assist educational professionals in determining what and how they teach, and at the same time promote scientific literacy in students, thereby increasing the overall population of scientifically literate students.

Appendix A

Attitudes Towards Science Inventory

Demographic Data

Please tell us your Age, Gender, and Race/ Ethnicity, and your science teacher's gender. Note that your name will **not** appear anywhere on the survey or answer sheet.

1. Age

- ☐ 8 years old
- ☐ 9 years old
- ☐ 10 years old
- ☐ 11 years old
- ☐ 12 years old or older

2. Gender

- ☐ Male
- ☐ Female

3. Ethnicity

- ☐ African American/ Black
- ☐ Caucasian/ White
- ☐ Asian American
- ☐ Hispanic/ Latino
- ☐ Multi Racial
- ❍ Other ____________

4. Ethnic Identity

- ☐ African American/ Black
- ☐ Caucasian/ White
- ☐ Asian American
- ☐ Hispanic/ Latino
- ☐ Multi Racial
- ☐ Other ____________

5. First Language

- ☐ English
- ☐ Spanish
- ☐ French
- ☐ Japanese
- ☐ Chinese
- ☐ Other ___________

6. Years in the US

- ☐ less than 1 year
- ☐ 1 to 3 years
- ☐ more than 3 years

General Questions

1. My parents/guardian expect me to complete at least
    a. Elementary school
    b. Middle school
    c. Trade/vocational school
    d. 2-year college
    e. 4-year college
    f. I do not know

2. My parents/guardian hope that I will complete
    a. Elementary school
    b. Middle school
    c. Trade/vocational school
    d. 2-year college
    e. 4-year college
    f. I do not know

3. The adults(s) with who I live have completed
    a. Elementary school
    b. Middle school
    c. Trade/vocational school
    d. 2-year college
    e. 4-year college
    f. I do not know

Survey of Attitudes Towards Science

The following statements are about the study of science. Please listen to, and read, each statement carefully. Use the following scale to show how much you agree or disagree with each statement.

If you STRONGLY DISAGREE	□	(2)	(3)	(4)	(5)
If you AGREE	(1)	□	(3)	(4)	(5)
If you are UNDECIDED	(1)	(2)	□	(4)	(5)
If you AGREE	(1)	(2)	(3)	□	(5)
If you STRONGLY AGREE	(1)	(2)	(3)	(4)	□

It is important that you respond to *every statement*, and that you fill in only one number per statement.

Attitudes Toward Science Inventory

ATSI ITEM STATEMENTS	STTONGLY	AGREE	UNDECIDE	DISAGREE	STRONGLY
1. Science is useful for solving the problems of everyday life.	1	2	3	4	5
2. Science is something that I enjoy very much.	1	2	3	4	5
3. I like the easy science assignments best.	1	2	3	4	5
4. I do not very well in science.	1	2	3	4	5
5. Science teachers show little interest in their students.	1	2	3	4	5
6. Doing science labs or hands-on activities is fun.	1	2	3	4	5
7. I feel at ease in a science class.	1	2	3	4	5
8. I would like to do some extra or un-assigned reading in science.	1	2	3	4	5
9. There is little need for science in most of today's jobs.	1	2	3	4	5
10. Science is easy for me.	1	2	3	4	5
11. When I hear the word "science," I have a feeling of dislike.	1	2	3	4	5
12. Most people should study some science.	1	2	3	4	5
13. I would like to spend less time in school studying science.	1	2	3	4	5
14. Sometimes I read ahead in our science book.	1	2	3	4	5
15. Science is helpful in understanding today's world.	1	2	3	4	5
16. I usually understand what we are talking about in science.	1	2	3	4	5
17. Science teachers make science interesting for me.	1	2	3	4	5
18. I do not like anything about science.	1	2	3	4	5
19. No matter how hard I try, I cannot understand science.	1	2	3	4	5
20. I feel tense or upset when someone talks to me about science.	1	2	3	4	5
21. Science teachers present materials in a way that I understand.	1	2	3	4	5

22. I often think, “I cannot do this,” when a science assignment seems hard.	1	2	3	4	5
23. Science is of great importance to a country’s development.	1	2	3	4	5
24. It is important to know science in order to get a good job.	1	2	3	4	5
25. It does not disturb or upset me to do science assignments.	1	2	3	4	5
26. I would like a job that does not use any science.	1	2	3	4	5
27. Science teachers know when I am having trouble with my assignments.	1	2	3	4	5
28. I enjoy talking to other people about science.	1	2	3	4	5
29. I enjoy watching a science program on television.	1	2	3	4	5
30. I am good at working science labs and hands-on activities.	1	2	3	4	5
31. Science teachers do not seem to enjoy teaching science.	1	2	3	4	5
32. I like the challenge of science assignments.	1	2	3	4	5
33. You can get along perfectly well in everyday life without science.	1	2	3	4	5
34. Working with science upsets me.	1	2	3	4	5
35. I remember most of the things I learn in science class.	1	2	3	4	5
36. It makes me nervous to even think about doing science.	1	2	3	4	5
37. I would rather be told scientific facts than find them out from experiments.	1	2	3	4	5
38. Most of the ideas in science are not very useful.	1	2	3	4	5
39. It scars me to have to take a science class.	1	2	3	4	5
40. Science teachers are willing to give me individual help.	1	2	3	4	5
41. The only reason I am talking science is because I have to.	1	2	3	4	5
42. It is important to me to understand the work I do in the science class.	1	2	3	4	5
43. I have a good feeling toward science.	1	2	3	4	5
44. Science teachers know a lot about science.	1	2	3	4	5
45. Science is one of my favorite subjects.	1	2	3	4	5
46. Science teachers do not like students to ask questions.	1	2	3	4	5
47. I have a real desire to learn science.	1	2	3	4	5
48. If I do not see how to do a science assignment right away, I never get it.	1	2	3	4	5

Appendix B

Contemporary Issues in Biology Combined Survey

Fill out the questions by clicking in the bubbles. It is important that you respond to every statement, and that you fill in only one number per statement.

Please only answer with "Undecided" when absolutely necessary.

Demographic Data

Please tell us your Gender and Race/ Ethnicity. Note that your name will not appear anywhere on the survey.

1. Gender

- ☐ Male
- ☐ Female

2. Ethnicity

- ☐ African American/ Black
- ☐ Caucasian/ White
- ☐ Asian American
- ☐ Hispanic/ Latino
- ☐ Multi Racial
- ☐ Other ____________

Survey of Attitudes Towards Science

The following statements are about the study of science. Please read each statement carefully. Use the following scale to show how much you agree or disagree with each statement.

1. If you STRONGLY DISAGREE
2. If you DISAGREE
3. If you are UNDECIDED
4. If you AGREE
5. If you STRONGLY AGREE

1. Science is useful for solving the problems of everyday life.
   1. STRONGLY DISAGREE
   2. DISAGREE
   3. UNDECIDED
   4. AGREE
   5. STRONGLY AGREE

2. Science is something that I enjoy very much.
   1. STRONGLY DISAGREE
   2. DISAGREE
   3. UNDECIDED
   4. AGREE
   5. STRONGLY AGREE

3. I like the easy science assignments best.
   1. STRONGLY DISAGREE
   2. DISAGREE
   3. UNDECIDED
   4. AGREE
   5. STRONGLY AGREE

4. I do not very well in science.
   1. STRONGLY DISAGREE
   2. DISAGREE
   3. UNDECIDED
   4. AGREE
   5. STRONGLY AGREE

5. Science teachers show little interest in their students.
   1. STRONGLY DISAGREE
   2. DISAGREE
   3. UNDECIDED
   4. AGREE
   5. STRONGLY AGREE

6. Doing science labs or hands-on activities is fun.
   1. STRONGLY DISAGREE
   2. DISAGREE
   3. UNDECIDED
   4. AGREE
   5. STRONGLY AGREE

7. I feel at ease in a science class.
   1. STRONGLY DISAGREE
   2. DISAGREE
   3. UNDECIDED
   4. AGREE
   5. STRONGLY AGREE

8. I would like to do some extra or un-assigned reading in science.
   1. STRONGLY DISAGREE
   2. DISAGREE
   3. UNDECIDED
   4. AGREE
   5. STRONGLY AGREE

9. There is little need for science in most of today's jobs.
   1. STRONGLY DISAGREE
   2. DISAGREE
   3. UNDECIDED
   4. AGREE
   5. STRONGLY AGREE

10. Science is easy for me.
    1. STRONGLY DISAGREE
    2. DISAGREE
    3. UNDECIDED
    4. AGREE
    5. STRONGLY AGREE

11. When I hear the word "science," I have a feeling of dislike.
    1. STRONGLY DISAGREE
    2. DISAGREE
    3. UNDECIDED
    4. AGREE
    5. STRONGLY AGREE

12. Most people should study some science.
    1. STRONGLY DISAGREE
    2. DISAGREE
    3. UNDECIDED
    4. AGREE
    5. STRONGLY AGREE

13. I would like to spend less time in school studying science.
    1. STRONGLY DISAGREE
    2. DISAGREE
    3. UNDECIDED
    4. AGREE
    5. STRONGLY AGREE

14. Sometimes I read ahead in our science book.
    1. STRONGLY DISAGREE
    2. DISAGREE
    3. UNDECIDED
    4. AGREE
    5. STRONGLY AGREE

15. Science is helpful in understanding today's world.
    1. STRONGLY DISAGREE
    2. DISAGREE
    3. UNDECIDED
    4. AGREE
    5. STRONGLY AGREE

16. I usually understand what we are talking about in science.
    1. STRONGLY DISAGREE
    2. DISAGREE
    3. UNDECIDED
    4. AGREE
    5. STRONGLY AGREE

17. Science teachers make science interesting for me.
    1. STRONGLY DISAGREE
    2. DISAGREE
    3. UNDECIDED
    4. AGREE
    5. STRONGLY AGREE

18. I do not like anything about science.
    1. STRONGLY DISAGREE
    2. DISAGREE
    3. UNDECIDED
    4. AGREE
    5. STRONGLY AGREE

19. No matter how hard I try, I cannot understand science.
    1. STRONGLY DISAGREE
    2. DISAGREE
    3. UNDECIDED
    4. AGREE
    5. STRONGLY AGREE

20. I feel tense or upset when someone talks to me about science.
    1. STRONGLY DISAGREE
    2. DISAGREE
    3. UNDECIDED
    4. AGREE
    5. STRONGLY AGREE

21. Science teachers present materials in a way that I understand.
    1. STRONGLY DISAGREE
    2. DISAGREE
    3. UNDECIDED
    4. AGREE
    5. STRONGLY AGREE

22. I often think, "I cannot do this," when a science assignment seems hard.
    1. STRONGLY DISAGREE
    2. DISAGREE
    3. UNDECIDED
    4. AGREE
    5. STRONGLY AGREE

23. Science is of great importance to a country's development.
    1. STRONGLY DISAGREE
    2. DISAGREE
    3. UNDECIDED
    4. AGREE
    5. STRONGLY AGREE

24. It is important to know science in order to get a good job.
    1. STRONGLY DISAGREE
    2. DISAGREE
    3. UNDECIDED
    4. AGREE
    5. STRONGLY AGREE

25. It does not disturb or upset me to do science assignments.
    1. STRONGLY DISAGREE
    2. DISAGREE
    3. UNDECIDED
    4. AGREE
    5. STRONGLY AGREE

26. I would like a job that does not use any science.
    1. STRONGLY DISAGREE
    2. DISAGREE
    3. UNDECIDED
    4. AGREE
    5. STRONGLY AGREE

27. Science teachers know when I am having trouble with my assignments.
    1. STRONGLY DISAGREE
    2. DISAGREE
    3. UNDECIDED
    4. AGREE
    5. STRONGLY AGREE

28. I enjoy talking to other people about science.
    1. STRONGLY DISAGREE
    2. DISAGREE
    3. UNDECIDED
    4. AGREE
    5. STRONGLY AGREE

29. I enjoy watching a science program on television.
    1. STRONGLY DISAGREE
    2. DISAGREE
    3. UNDECIDED
    4. AGREE
    5. STRONGLY AGREE

30. I am good at working science labs and hands-on activities.
    1. STRONGLY DISAGREE
    2. DISAGREE
    3. UNDECIDED
    4. AGREE
    5. STRONGLY AGREE

31. Science teachers do not seem to enjoy teaching science.
    1. STRONGLY DISAGREE
    2. DISAGREE
    3. UNDECIDED
    4. AGREE
    5. STRONGLY AGREE

32. I like the challenge of science assignments.
    1. STRONGLY DISAGREE
    2. DISAGREE
    3. UNDECIDED
    4. AGREE
    5. STRONGLY AGREE

33. You can get along perfectly well in everyday life without science.
    1. STRONGLY DISAGREE
    2. DISAGREE
    3. UNDECIDED
    4. AGREE
    5. STRONGLY AGREE

34. Working with science upsets me.
    1. STRONGLY DISAGREE
    2. DISAGREE
    3. UNDECIDED
    4. AGREE
    5. STRONGLY AGREE

35. I remember most of the things I learn in science class.
    1. STRONGLY DISAGREE
    2. DISAGREE
    3. UNDECIDED
    4. AGREE
    5. STRONGLY AGREE

36. It makes me nervous to even think about doing science.
    1. STRONGLY DISAGREE
    2. DISAGREE
    3. UNDECIDED
    4. AGREE
    5. STRONGLY AGREE

37. I would rather be told scientific facts than find them out from experiments.
    1. STRONGLY DISAGREE
    2. DISAGREE
    3. UNDECIDED
    4. AGREE
    5. STRONGLY AGREE

38. Most of the ideas in science are not very useful.
    1. STRONGLY DISAGREE
    2. DISAGREE
    3. UNDECIDED
    4. AGREE
    5. STRONGLY AGREE

39. It scars me to have to take a science class.
    1. STRONGLY DISAGREE
    2. DISAGREE
    3. UNDECIDED
    4. AGREE
    5. STRONGLY AGREE

40. Science teachers are willing to give me individual help.
    1. STRONGLY DISAGREE
    2. DISAGREE
    3. UNDECIDED
    4. AGREE
    5. STRONGLY AGREE

41. The only reason I am talking science is because I have to.
    1. STRONGLY DISAGREE
    2. DISAGREE
    3. UNDECIDED
    4. AGREE
    5. STRONGLY AGREE

42. It is important to me to understand the work I do in the science class.
    1. STRONGLY DISAGREE
    2. DISAGREE
    3. UNDECIDED
    4. AGREE
    5. STRONGLY AGREE

43. I have a good feeling toward science.
    1. STRONGLY DISAGREE
    2. DISAGREE
    3. UNDECIDED
    4. AGREE
    5. STRONGLY AGREE

44. Science teachers know a lot about science.
    1. STRONGLY DISAGREE
    2. DISAGREE
    3. UNDECIDED
    4. AGREE
    5. STRONGLY AGREE

45. Science is one of my favorite subjects.
    1. STRONGLY DISAGREE
    2. DISAGREE
    3. UNDECIDED
    4. AGREE
    5. STRONGLY AGREE

46. Science teachers do not like students to ask questions.
    1. STRONGLY DISAGREE
    2. DISAGREE
    3. UNDECIDED
    4. AGREE
    5. STRONGLY AGREE

47. I have a real desire to learn science.
    1. STRONGLY DISAGREE
    2. DISAGREE
    3. UNDECIDED
    4. AGREE
    5. STRONGLY AGREE

48. If I do not see how to do a science assignment right away, I never get it.
    1. STRONGLY DISAGREE
    2. DISAGREE
    3. UNDECIDED
    4. AGREE
    5. STRONGLY AGREE

Survey of Science Self-Efficacy

This part of the survey contains 17 statements about your confidence in doing things related to biology. For each question, think about how confident you are just your own thoughts and feelings about these topics.

Each answer in this section should be filled in by clicking the bubbles with these options:

A. If you are <u>TOTALLY</u> CONFIDENT that you can do the task.
B. If you are <u>SOMEWHAT</u> CONFIDENT that you can do the task.
C. If you are <u>UNDECIDED</u> that you can do the task.
D. If you are <u>ONLY A LITTLE</u> CONFIDENT that you can do the task.
E. If you are <u>NOT AT ALL</u> CONFIDENT that you can do the task.

Practice Item
How confident are you that you could give a presentation about birds in northern Arizona?
Suppose that you were “fairly confident” that you could give a presentation about birds in northern Arizona. You would write the letter “C” in the blank next to the question.

1. How confident are you that after reading an article about a biology experiment, you could write a summary of its main points?
   A. TOTALLY CONFIDENT
   B. SOMEWHAT CONFIDENT
   C. UNDECIDED
   D. ONLY A LITTLE CONFIDENT
   E. NOT AT ALL CONFIDENT

2. How confident are you that you could critique a laboratory report written by another student?
   A. TOTALLY CONFIDENT
   B. SOMEWHAT CONFIDENT
   C. UNDECIDED
   D. ONLY A LITTLE CONFIDENT
   E. NOT AT ALL CONFIDENT

3. How confident are you that after reading an article about a biology experiment, you could explain its main ideas to another person?
   A. TOTALLY CONFIDENT
   B. SOMEWHAT CONFIDENT
   C. UNDECIDED
   D. ONLY A LITTLE CONFIDENT
   E. NOT AT ALL CONFIDENT

4. How confident are you that you could read the procedures for an experiment and feel sure about conducting the experiment on your own?
   A. TOTALLY CONFIDENT
   B. SOMEWHAT CONFIDENT
   C. UNDECIDED
   D. ONLY A LITTLE CONFIDENT
   E. NOT AT ALL CONFIDENT

5. How confident are you that after watching a television documentary dealing with some aspect of biology, you could write a summary of its main points?
   A. TOTALLY CONFIDENT
   B. SOMEWHAT CONFIDENT
   C. UNDECIDED
   D. ONLY A LITTLE CONFIDENT
   E. NOT AT ALL CONFIDENT

6. How confident are you that you will be successful in this course?
   A. TOTALLY CONFIDENT
   B. SOMEWHAT CONFIDENT
   C. UNDECIDED
   D. ONLY A LITTLE CONFIDENT
   E. NOT AT ALL CONFIDENT

7. How confident are you that after watching a television documentary dealing with some aspect of biology, you could explain its main ideas to another person?
   A. TOTALLY CONFIDENT
   B. SOMEWHAT CONFIDENT
   C. UNDECIDED
   D. ONLY A LITTLE CONFIDENT
   E. NOT AT ALL CONFIDENT

8. How confident are you that you will be successful in another biology course?
    A. TOTALLY CONFIDENT
    B. SOMEWHAT CONFIDENT
    C. UNDECIDED
    D. ONLY A LITTLE CONFIDENT
    E. NOT AT ALL CONFIDENT

9. How confident are you that after listening to a public lecture regarding some biology topic, you could write a summary of its main points?
    A. TOTALLY CONFIDENT
    B. SOMEWHAT CONFIDENT
    C. UNDECIDED
    D. ONLY A LITTLE CONFIDENT
    E. NOT AT ALL CONFIDENT

10. How confident are you that you would be successful in an ecology course?
    A. TOTALLY CONFIDENT
    B. SOMEWHAT CONFIDENT
    C. UNDECIDED
    D. ONLY A LITTLE CONFIDENT
    E. NOT AT ALL CONFIDENT

11. How confident are you that after listening to a public lecture regarding some biology topic, you could explain its main ideas to another person?
    A. TOTALLY CONFIDENT
    B. SOMEWHAT CONFIDENT
    C. UNDECIDED
    D. ONLY A LITTLE CONFIDENT
    E. NOT AT ALL CONFIDENT

12. How confident are you that you would be successful in a human physiology course?
    A. TOTALLY CONFIDENT
    B. SOMEWHAT CONFIDENT
    C. UNDECIDED
    D. ONLY A LITTLE CONFIDENT
    E. NOT AT ALL CONFIDENT

13. How confident are you that you could critique an experiment described in a biology textbook (i.e. lists the strengths and weaknesses)?
    A. TOTALLY CONFIDENT
    B. SOMEWHAT CONFIDENT
    C. UNDECIDED
    D. ONLY A LITTLE CONFIDENT
    E. NOT AT ALL CONFIDENT

14. How confident are you that you could tutor another student for this biology course?
    A. TOTALLY CONFIDENT
    B. SOMEWHAT CONFIDENT
    C. UNDECIDED
    D. ONLY A LITTLE CONFIDENT
    E. NOT AT ALL CONFIDENT

15. How confident are you that you could ask a meaningful question that could be answered experimentally?

A. TOTALLY CONFIDENT
B. SOMEWHAT CONFIDENT
C. UNDECIDED
D. ONLY A LITTLE CONFIDENT
E. NOT AT ALL CONFIDENT

16. How confident are you that you could explain something that you learned in this biology course to another person?

A. TOTALLY CONFIDENT
B. SOMEWHAT CONFIDENT
C. UNDECIDED
D. ONLY A LITTLE CONFIDENT
E. NOT AT ALL CONFIDENT

17. How confident are you that you could use a scientific approach to solve a problem at home?

A. TOTALLY CONFIDENT
B. SOMEWHAT CONFIDENT
C. UNDECIDED
D. ONLY A LITTLE CONFIDENT
E. NOT AT ALL CONFIDENT

Appendix C

Biology Self-Efficacy Scale

This survey contains 23 statements about your confidence in doing things related to biology. For each question, think about how confident you are just your own thoughts and feelings about these topics. There are *three* demographic questions as well.

All answers should be filled in on the bubble sheets provided. For each statement in the survey, fill in the bubble next to each question:

A. If you are <u>TOTALLY</u> CONFIDENT that you can do the task.
B. If you are <u>VERY</u> CONFIDENT that you can do the task.
C. If you are <u>FAIRLY</u> CONFIDENT that you can do the task.
D. If you are <u>ONLY A LITTLE</u> CONFIDENT that you can do the task.
E. If you are <u>NOT AT ALL</u> CONFIDENT that you can do the task.

Practice Item
How confident are you that you could give a presentation about birds in northern Arizona?

Suppose that you were "fairly confident" that you could give a presentation about birds in northern Arizona. You would write the letter "C" in the blank next to the question.
Thank you for your participation!

______ 1. How confident are you that after reading an article about a biology experiment, you could write a summary of its main points?
______ 2. How confident are you that you could critique a laboratory report written by another student?
______ 3. How confident are you that you could write an introduction to a lab report?
______ 4. How confident are you that after reading an article about a biology experiment, you could explain its main ideas to another person?
______ 5. How confident are you that you could read the procedures for an experiment and feel sure about conducting the experiment on your own?
______ 6. How confident are you that you could write the methods section of a lab report (i.e. describe the experimental procedures)?
______ 7. How confident are you that after watching a television documentary dealing with some aspect of biology, you could write a summary of its main points?
______ 8. How confident are you that you will be successful in this course?
______ 9. How confident are you that you could write up the results to a lab report?
______ 10. How confident are you that after watching a television documentary dealing with some aspect of biology, you could explain its main ideas to another person?
______ 11. How confident are you that you will be successful in another biology course?
______ 12. How confident are you that you could write the conclusion to a lab report?
______ 13. How confident are you that after listening to a public lecture regarding some biology topic, you could write a summary of its main points?

______ 14. How confident are you that you would be successful in an ecology course?
______ 15. How confident are you that you could analyze a set of data (i.e., look at the relationships between variables)?
______ 16. How confident are you that after listening to a public lecture regarding some biology topic, you could explain its main ideas to another person?
______ 17. How confident are you that you would be successful in a human physiology course?
______ 18. How confident are you that you could tutor another student on how to write a lab report?
______ 19. How confident are you that you could critique an experiment described in a biology textbook (i.e. lists the strengths and weaknesses)?
______ 20. How confident are ou that you could tutor another student for this biology course?
______ 21. How confident are you that you could ask a meaningful question that could be answered experimentally?
______ 22. How confident are you that you could explain something that you learned in this biology course to another person?
______ 23. How confident are you that you could use a scientific approach to solve a problem at home?

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ABSTRACT

EVALUATION OF STUDENT ATTITUDE TOWARD SCIENCE AND SELF-EFFICACY IN A NON-MAJORS COLLEGE BIOLOGY COURSE

By Anne Elizabeth Schruba, M.Ed., 2008
College of Education
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In an effort to increase biological and general scientific literacy to meet the needs of an increasingly scientifically literate society, this study evaluated the attitudes and self-efficacy of 128 students in a non-majors college biology course in an urban private university in North Texas. The students used the Attitudes Toward Science Inventory (ATSI) for attitude and the Biology Self-Efficacy Scale (BSES) for self-efficacy at the beginning of the semester and again after ten weeks of instruction. Data from the ATSI and the BSES were analyzed to determine a relationship between attitude and self-efficacy and to evaluate changes due to instruction. Correlations were significant and t-tests reflected an increase in positive attitudes and a decrease in self-efficacy after instruction.