Change in student beliefs about attitudes toward science in grades 6-9

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Abstract

The study reports on an investigation of the impact of a Science-Technology-Society (STS) approach in promoting more positive student attitudes toward science that are recommended by current reform documents. A total of 609 students from grades six through nine were selected for a survey of attitudes in two class sections assigned as either experimental (STS oriented class) or control group (textbook oriented class). The results indicate that students in classes taught with an STS approach develop more positive attitudes toward science when compared to students in classes taught with a textbook-oriented approach. The STS approach to science teaching works equally well for male and female students regarding student attitudes toward science. Significant differences were not found between male and female students in terms of improving positive attitudes concerning science study.

Introduction

Attitudes towards science, scientists, and learning science have always been a concern for science educators. Attitude is very broadly used in discussing issues in science education and is often used in various contexts. Two broad categories are distinguishable. The first one is attitude toward science (e.g., interest in science, attitude toward scientists, or attitudes toward social responsibility in science). *Attitude towards science* can be defined as the feelings, beliefs, and values held about an object that may be the endeavor of science, school science, the impact of science and technology on society, or scientists. The second one is scientific attitude (i.e., open-minded, honesty, or skepticism). *Scientific attitude* is the desire to know and understand, questioning to all statements, search for data and their meaning, search for verification, and consideration of consequences (Gardner, 1975; Osborne, Simon & Collins, 2003).

Research studies that indicate positive correlations between achievement in science courses and positive attitudes toward science, attitude and certain characteristics of the classroom environments that include personal support, use of a variety of teaching strategies, innovative learning activities, and student-centered instructional designs have all been reported in the recent research journal (Osborne, Simon & Collins, 2003; Russell & Hollander, 1975; Shrigley, Koballa & Simpson, 1988; French & Russell, 2006). Attitudes towards science and scientists influence views of science, future career awareness, and classroom participation. Students who have positive attitudes show increased attention to classroom instruction and participate more in science activities (Germann, 1988; Jarvis & Pell, 2005).

Most research indicates that students develop more negative attitudes toward studying science, toward their science classes, and toward their science teachers the longer they study typical school science (Yager & McCormack, 1989). It is important to develop student positive attitude toward science. When they have positive attitudes, the learning of scientific information and science process skills are enhanced (Yager, 1996). After fourth grade student attitude toward science starts to decline through junior and high school (Penick & Yager, 1982). Assessment of student attitudes toward science have been conducted and reported. Student responses indicate that student interest in science decreases the longer the students study science (NAEP, 1978). Reasons why students develop more negative attitudes towards science as they move through elementary school include;

- Students are interested in a number of non-school activities when they get older
- Low achievement with school work
- More emphasis on specific science facts
- More emphasis on test results
- Not much opportunity for students to enjoy science (Yager, 1996)

Research studies indicate many factors influencing attitudes toward science. Probably gender is the most significant variable related student attitudes toward science (Gardner, 1975; Schibeci, 1984; Weinburgh, 1995). Children receive messages about gender and ethnic stereotypes everyday from television programs and commercials, books, and the adults around them. They also see pictures of scientists most of whom are all men, are all white, and have strange/weird behaviors. The strong correlation between attitude toward science and achievement indicate little difference between girls and boys. Also, more positive attitudes are necessary for girls to enable them to achieve high scores (Weingburgh, 1995; Jarvis &Pell, 2005).

The National Science Teachers Association defined the STS approach as the teaching and learning science and technology in the context of human experience (NSTA, 1990). STS means focusing upon current issues and attempts at their resolution as the best way of preparing students for current and future citizenship roles. This means identifying local, regional, national, and international problems with students, planning for individual and group activities which address them, and moving to actions designed to resolve the issues investigated. The emphasis is on responsible decision-making in the real world of the student. STS provides a means for achieving scientific and technological literacy for all. The emphasis is on responsible decision-making in the real world of the student where science and technology are components.

The view of the student where the STS approaches are practiced make classrooms very different than they are where traditional teaching is practiced. In traditional teaching the teacher decides which topics to include, in what sequence, and in what ways. The teacher is the authority and students are the passive recipients. Conversely, students are central in the STS approach. Students generate their own questions rather than purely relying on the questions provided by others. Based on their own questions, student view their own previous understandings of the problem and issues. Student-directed questions further serve to define problems, potential solutions, and actions need to resolve them. This enables students to see/ do science in the same way that scientists do. This makes science more meaningful, exciting, and appropriate for most students. The main goal of the STS approach is to achieve scientific literacy for all. It creates student-centered environments where students improve on their own ideas, raise questions, and undertake investigations. The STS approach starts with real world issues, and problems that related to students lives. Table 1 indicates the differences between students involved in an STS program and those in a traditional science program in terms of the attitude domain

Table 1: Contrast between STS Programs and Traditional Science Programs in terms of the Attitude Domain

STS	Traditional
Students continually offer ideas	Students have few original ideas
Students interest increases from grade level to grade level and in specific courses	Student interest in science declines at all grade levels
Students become more curious about the material world	Science seems to decrease curiosity
Students see their teacher as a facilitator/guide	Students see their teacher as a purveyor of information
Students see science as a way of dealing with problems	Students see science as information to learn

The Iowa Chautauqua Program

The Iowa Chautauqua Program (See Figure 1) which was supported by a National Science Foundation (NSF) grant to the National Science Teachers Association (NSTA) was developed in 1983 to study a teacher education model for stimulating reform in science classrooms. The program began in Iowa with 30 teachers enrolled

in a program in one center for 230 teachers enrolled in five centers across the state during the two decades following its inception. Over 9,000 teachers have been enrolled during last two decades.

The Chautauqua program identified six important domains for developing instructional goals and assessing successes in meeting them. They include;

1. Concept domain (mastering basic content constructs)
2. Process domain (learning skills scientists use as they seek answers to their questions about the natural world)
3. Application domain (using concepts and processes in new situations)
4. Creativity domain (improving quantity and quality of questions, explanations, and text for the validity of personal generated explanations)
5. Attitude domain (developing more positive feelings concerning the usefulness of science, science study, science teachers and science careers)
6. World View domain (how efforts in schools can assist students in understanding the nature of science and to practice the basic components such as questioning, explaining, and testing objects and events in the natural world (Enger & Yager 1998, Yager & Akcay, 2007,2008).

A major aim of the Chautauqua Program has been to counter the typical and continuous decline in positiveattitudes toward science associated with more years of schooling. Attitudes can serve both as an outcome of science learning (a dependent variable) and as a factor which affects learning (an independent variable). The attitude domain includes:

- Development of more positive students attitude toward science in general
- Development of positive attitudes toward oneself (an “I can do it” attitude)
- Development of sensitivity to, and respect for, the feeling of other people
- Expression of personal feelings in a constructive way
- Exploration of human emotions (in science)
- Decision-making about personal values
- Decision-making about social and environmental issues (Enger & Yager, 2001, 2009).

Figure 1: The IOWA CHAUTAUQUA MODEL: A Professional Development Model as Approved by the National Diffusion Network

LEADERSHIP CONFERENCE

A Two Week Long Conference Designed To
1. Prepare staff team for conducting a workshop series which follows for 30 new teachers.
a) One lead teacher per ten new teachers
b) Scientist from a variety of disciplines
c) Scientists from industry
d) Administrators
e) Science Supervisors/Coordinators as chair of staff teams
2. Organization and scheduling for each workshop
3. Publicity and reporting
4. Assessment strategies
a) Six domains
b) Use of reports
c) Active Research (Every teacher as researcher)
d) New research plans for Lead Teachers

THREE OR FOUR WEEK SUMMER WORKSHOP

STS Experiences
1. Includes special activities and field experiences that relate specific content within the disciplines of biology, chemistry, earth science, and physics.
2. Makes connections between science, technology, society within the context of real world issues.
3. Issues such as air quality, water quality, land use/management are used as the context for concept and process skills development.
4. Every staff member and every teacher participant selects an action and completes at least one Action Research Project.
5. Plan for continuing Action Research in the classroom over the next academic year.
6. Complete several videotapes of teaching experiences with both self and group analyses.

ACADEMIC YEAR WORKSHOP SERIES

Fall Short Course -> Interim Projects -> Spring Short Course
(3 days) (3 days)

Awareness Workshop	Three Month Interim Project	Final Workshop
20 hr Instructional Block(Thursday pm. Friday, & Saturday)	**The STS Module**	**20 hr Instructional Block** (Thursday pm. Friday, & Saturday)
Activities Include: 1. Review problems with traditional views of science and science teaching 2. Outline essence of STS 3. Define techniques for developing STS modules and assessing their effectiveness 4. Select a tentative module topic 5. Practice with specific assessment tools in each STS Domain. 6. Use Lesson Study designs 7. Analysis one videotape of Middle Class	Activities Include: 1. Developing instructional plan for minimum of twenty days 2. Administer pretests in five domains 3. Teach STS module 4. Collect posttest information 5. Communicate with regional staff, Lead Teachers, and central Chautauqua staff 6. Complete and analysis one class videotape with colleagues from given sites	Activities Include: 1. Report on STS experience 2. Report on assessment efforts 3. Interact on new information concerning STS 4. Show one videotape of classes 5. Analyze changes from summer, fall, and spring 6. Plan for involvement in professional meetings 7. Plan for next-step STS initiatives (including complete reorganizing of existing courses)

Research Questions

"Lead teachers" are experienced and successful STS teachers who become members of the instructional staff for lead new Chautauqua Professional Development efforts which operate for a given academic year in Iowa. They offer assistance in planning a new instructional series at each of as many as five sites across the state. In addition, these "lead" teachers agree to participate in annual research efforts with their own students. Twelve such teachers agreed to provide pretest and posttest data for this study to respond to the following questions in terms of attitude toward science.

1. Do students who experience their science in an STS format excel in terms of attitude toward science over students who experience science in a more typical textbook-oriented format?

2. After experiencing science in an STS format, are there any differences in attitude toward science between male and female students?
3. After experiencing science in an STS format, do STS high ability students excel in terms of more positive attitudes toward science over textbook-oriented high ability students?
4. After experiencing science in an STS format, do STS low-ability students excel more in terms of attitude toward science over textbook-oriented low ability students?

Instrumentation

The Iowa Assessment Package (Yager, Blunck, & Ajam, 1990; Enger & Yager, 1998) was used to assess the learning achievements of the experimental and the control groups. In this package instruments for assessing student growth in each of the six domains of science teaching are provided. Directions are given for using each instrument. Student response sheets and teacher tabulation sheets are also provided when appropriate. The data for the present study were collected using instruments entitled Attitude, Preferences, and Understanding that were adapted from the National Assessment of Education Progress (NAEP) 1977 measure of attitudes about science. Validity is provided by the officials and writers for NAEP. The specific validity of two tests were established with agreement by NAEP testing experts and thirty Chautauqua lead teachers. The reliability of the attitudes and perceptions was determined to range form 0.79-0.83, (test-retest two weeks later). The reliability coefficients for the assessment items were obtained by using the test-retest method with students in classes taught by all lead teachers for a given year. NAEP reports the reliability of attitude items to be 0.82. The mean, standard divisions (SD), and t- values were calculated and used to assess differences between pre- and post-tests scores for attitude toward science domain for all students in two class sections. The 5% level of significance ($P \leq 0.05$) was used to assess statistical differences.

Data Collection Procedures

Pretest and posttest for attitude toward science domain of science teaching were administered to students in both experimental and control groups. The pretests were spread over a two week interval prior to the beginning of the experiment. The posttests were conducted one semester later following the instruction. The attitude and perception data were collected as a way of closing the semester. In general, an emphasis upon assessment and student change as evidenced by pretesting and

posttesting was maintained as a normal part of science instruction. Figure 2 is a list of differences between STS instruction and textbook-oriented instruction:

Figure 2: Comparison of Instructional Strategies Characterizing STS and Textbook-Oriented Classes

Textbook-Oriented	STS
Textbook visible and used frequently	Textbook used only when it is needed as source of information
Teachers provide information for students to record and to repeat on tests	Teachers assist students in finding answer to their own questions; teachers rarely provide information
Activities are all prescribed, including goals, procedures, and often results	Students plan activities as a way of testing their own ideas and explanations
No focus on current problems and issues	Current problems and issues often provide the context of the study
Science defined by what information is included in the text	Science defined as questions, possible answers to questions, and testing the possible answers which emerge
Teachers plan each lesson carefully	Teachers focus on goals and involve students in planning activities, actions, and source of information
Students doing what text and teacher direct them to do	Students proposing actions, information sources, and new questions
Focus upon words and terms from textbook	Terms rarely used as a focus by themselves; special terms are used only after meaning has been established
Ideas and information are presented for mastery	Ideas and information sought out to respond to issues and questions
No use of newspaper and periodicals	Frequent use of news current reports and current situations
Much work on text and teacher-prepared worksheets	No work on text and teacher-prepared worksheets
Science not viewed as operating in the school and/or community; i.e., no local relevance	Nearly all questions, issues, and class activities have a base and a relevance at the local level
Much time spent by teacher in preparing lessons	Students involved as much as (if not more than) teacher in preparing for individual lesson
Class discussion and laboratories focus on competition and getting right answer	Discussion and laboratories focus on responding to issues, questions, and problems
Quizzes and tests focus on student recall	Evaluation focuses on what students can do; i.e. , how they can use information and skills

(Yager, 1996, 2000, 2001, NSTA, 1990).

Result of study

Table 2 indicates comparisons of the differences for attitude toward science were made between students who were instructed in the STS and those in textbook-oriented classrooms. The results indicate that the average score on the pretest score is not different for the two groups. No significant differences were found in the two sections when there were two teaching methods used on the pretest scores for attitude toward science. However, significant difference were found between the two teaching methods on the post-test scores for attitude toward science found across grades six through nine. Students in classes taught with an STS approach developed more positive attitudes toward science when compared to students in classes taught with a textbook-oriented approach

Table 2: Comparisons between the STS and the Textbook-oriented Students concerning their Attitudes toward Science

		STS			Textbook-Oriented				
		n	Mean	SD	n	Mean	SD	t	p
Grade 6	Pre test-Attitude	77	12.35	2.2	81	12.14	2.1	.34	.55
	Post test-Attitude	77	20.10	3.0	81	11.42	2.6	370.39	.00*
Grade 7	Pre test-Attitude	77	10.90	2.8	76	10.57	2.7	.54	.46
	Post test-Attitude	77	18.08	3.8	76	10.41	3.2	179.40	.00*
Grade 8	Pre test-Attitude	76	11.16	2.8	75	10.63	2.7	1.42	.24
	Post test-Attitude	76	18.11	3.8	75	10.09	2.8	213.20	.00*
Grade 9	Pre test-Attitude	71	11.65	2.3	76	11.71	2.2	.03	.86
	Post test-Attitude	71	19.42	3.3	76	11.08	2.7	278.42	.00*

*indicate significance at $p < 0.05$ level.

Table 3 indicates comparisons of pre- and post-test average scores for male students concerning attitude toward science in STS-oriented classes and textbook-oriented classes. No significant differences found on pretest scores between the

two groups except for grade eight male students. A significant difference did exist with pretest scores between STS-oriented classes and textbook-oriented classes for grade eight male students. For male students, significant differences were found between the two teaching methods on the post-test scores for positive attitudes toward science across grade six through nine. Male students in classes taught with an STS approach were able to develop more positive attitudes toward science when compared to students in classes taught with a textbook-oriented approach.

Table 3: Comparisons between the Male STS Students and Their Textbook-oriented Counterparts concerning Attitudes toward Science

		STS (Males)			Textbook-Oriented (Males)				
		n	Mean	SD	n	Mean	SD	t	p
Grade 6	Pre test-Attitude	36	14.11	1.4	42	13.43	1.6	4.14	.05*
	Post test-Attitude	36	21.17	3.0	42	12.24	2.7	198.18	.00*
Grade 7	Pre test-Attitude	37	11.98	2.9	37	11.16	2.9	1.15	.29
	Post test-Attitude	37	18.05	4.1	37	10.49	3.1	78.55	.00*
Grade 8	Pre test-Attitude	39	12.79	2.1	37	11.11	3.2	7.66	.00*
	Post test-Attitude	39	18.31	3.2	37	10.24	3.1	123.96	.00*
Grade 9	Pre test-Attitude	35	12.91	1.8	39	12.79	1.8	.08	.78
	Post test-Attitude	35	19.60	3.0	39	11.57	2.7	149.72	.00*

*indicate significance at $p < 0.05$ level.

Table 4 indicates comparisons of pre- and post-test average scores for female students concerning attitude toward science in STS-oriented classes and textbook-oriented classes. No significant differences found on pretest scores for the two groups. Significant differences were found between the two teaching methods on the post-test scores for attitude toward science across grades six through nine. Female students in classes taught with an STS approach were able to develop more

positive attitudes toward science when compared to students in classes taught with a textbook-oriented approach.

Table 4: Comparisons between the Female STS Students and Their Textbook-oriented Counterparts concerning Attitudes toward Science

		STS (Females)			Textbook-Oriented (Females)				
		n	Mean	SD	n	Mean	SD	t	p
Grade 6	Pre test-Attitude	41	10.80	1.5	39	10.77	1.8	.01	.09
	Post test-Attitude	41	19.15	2.9	39	10.54	2.3	221.80	.00*
Grade 7	Pre test-Attitude	40	9.96	2.4	39	10.00	2.5	.002	.96
	Post test-Attitude	40	18.10	3.6	39	10.33	3.3	99.45	.00*
Grade 8	Pre test-Attitude	37	9.43	2.4	38	10.16	2.1	1.98	.16
	Post test-Attitude	37	17.89	4.5	38	9.95	2.5	90.78	.00*
Grade 9	Pre test-Attitude	36	10.42	2.0	37	10.57	1.9	.11	.74
	Post test-Attitude	36	19.24	3.6	37	10.62	2.8	131.50	.00*

*indicate significance at $p < 0.05$ level.

Table 5 gender related differences for STS students are analyzed. Table 5 indicates comparisons between male and female students in classes taught with an STS approach concerning positive attitudes toward science. Although significant differences were found between the two teaching methods on the pre-test scores for attitudes toward science across grades six through nine, no significant differences were not found between male and female students for attitude toward science across grades six through nine for post-test scores except for six grade. The STS approach to science teaching works equally well for male and female students concerning developing more positive attitudes toward science.

Table 5: Comparisons between Male and Female Students Taught Using STS Approach concerning Attitudes toward Science

		Male			Female				
		n	Mean	SD	n	Mean	SD	t	p
Grade 6	Pre test-Attitude	36	14.11	1.4	41	10.81	1.5	99.45	.00*
	Post test-Attitude	36	21.17	3.0	41	19.15	2.9	9.25	.00*
Grade	Pre test-	37	11.89	2.9	40	9.98	2.4	10.14	.00*

7	Attitude								
	Post test-Attitude	37	18.05	4.1	40	18.10	3.8	.00	.96
Grade 8	Pre test-Attitude	39	12.80	2.1	37	9.43	2.4	43.23	.00*
	Post test-Attitude	39	18.31	3.2	37	17.89	4.5	.22	.64
Grade 9	Pre test-Attitude	35	12.91	1.8	36	10.42	2.0	31.37	.00*
	Post test-Attitude	35	19.60	3.0	36	19.25	3.6	.20	.66

*indicate significance at $p < 0.05$ level.

Table 6 gender related differences were tested for the textbook-oriented approach. Comparisons were made between achievement of males and females in attitude toward science using analysis of variance procedures. Significant differences were found between male and female students in textbook-oriented sections in grade six and nine for pre-test scores. No significant differences were found between male and female students across grades six through nine for post-test scores in terms of more positive attitudes toward science. A significant difference did only exist with posttest score between male and female students in grade six concerning more positive attitudes toward science.

Table 6: Comparisons between Male and Female Students Taught Using the Textbook-oriented Approach concerning Attitudes toward Science

		Male			Female				
		n	**Mean**	**SD**	**n**	**Mean**	**SD**	**t**	**p**
Grade 6	Pre test-Attitude	42	13.43	1.6	39	10.77	1.8	51.07	.00*
	Post test-Attitude	42	12.24	2.7	39	10.54	2.3	9.36	.00*
Grade 7	Pre test-Attitude	37	11.16	2.9	39	10.00	2.5	3.51	.06
	Post test-Attitude	37	10.49	3.1	39	10.33	3.3	.04	.84
Grade 8	Pre test-Attitude	37	11.11	3.2	38	10.16	2.1	2.38	.13
	Post test-Attitude	37	10.24	3.1	38	9.95	2.5	.21	.65
Grade 9	Pre test-Attitude	39	12.80	1.8	37	10.57	1.9	27.72	.00*
	Post test-Attitude	39	11.51	2.7	37	10.62	2.8	2.03	.16

*indicate significance at $p < 0.05$ level.

High achieving students were defined as students who earned grades either of A or B in their coursework in both classes. Table 7 indicates comparisons of pre- and post-test average scores for high achieving students concerning attitude toward science in STS-oriented classes and textbook-oriented classes. No significant differences were found on pretest scores for the two groups. Significant differences were found between the two teaching methods on the post-test scores for more positive attitudes toward science across grades six through nine. High ability students in classes taught with an STS approach develop more positive attitudes toward science when compared to students in classes taught with a textbook-oriented approach.

Table 7: Comparisons between the STS High Achieving Students and Their Textbook-oriented Counterparts concerning Attitudes toward Science

		STS			Textbook-Oriented				
		n	Mean	SD	n	Mean	SD	t	p
Grade 6	Pre test-Attitude	33	13.00	1.8	31	12.52	1.9	1.10	.30
	Post test-Attitude	33	20.58	2.3	31	13.13	2.1	303.35	.00*
Grade 7	Pre test-Attitude	32	11.75	2.1	31	11.42	2.3	.36	.55
	Post test-Attitude	32	20.28	3.0	31	12.26	2.3	112.74	.00*
Grade 8	Pre test-Attitude	30	12.33	2.2	28	11.75	3.3	.92	.33
	Post test-Attitude	30	21.17	2.9	28	12.18	2.2	173.21	.00*
Grade 9	Pre test-Attitude	27	12.43	2.2	33	12.09	2.0	.54	.42
	Post test-Attitude	27	22.33	2.6	33	12.85	2.5	208.16	.00*

*indicate significance at $p < 0.05$ level.

Students who earned a grade of C or lower in science classes or who are not interested and less motivated to achieve up to their capacity in a science classroom were defined as “low ability”. Average scores for low achieving students were also compared in this study. Table 8 indicates comparisons of pre- and post-test average scores for low achieving students concerning attitude toward science in STS-oriented classes compared to the situation in textbook-oriented classes. No significant differences found on pretest scores between the two groups. Significant differences were found between the two teaching methods on the post-test scores for more positive attitudes towards science across grades six through nine.

Low-ability students in classes taught with an STS approach developed more positive attitudes toward science when compared to students in classes taught with a textbook-oriented approach.

Table 8: Comparisons between the STS Low Achieving Students and Their Textbook-oriented Counterparts concerning Attitudes toward Science

		STS			Textbook-Oriented				
		n	Mean	SD	n	Mean	SD	t	p
Grade 6	Pre test-Attitude	44	11.86	2.4	50	11.92	2.3	.01	.91
	Post test-Attitude	44	18.23	2.1	50	10.36	2.3	292.74	.00*
Grade 7	Pre test-Attitude	45	10.29	3.1	45	9.98	2.9	.24	.62
	Post test-Attitude	45	16.51	3.6	45	9.18	2.8	119.69	.00*
Grade 8	Pre test-Attitude	46	10.39	2.9	47	9.96	2.7	.56	.46
	Post test-Attitude	46	16.11	3.0	47	8.85	2.4	169.76	.00*
Grade 9	Pre test-Attitude	44	11.14	2.2	43	11.42	2.3	.35	.55
	Post test-Attitude	44	17.64	2.3	43	9.72	2.1	284.68	.00*

*indicate significance at $p < 0.05$ level.

Discussion and Implications

Results from tables 1 through 8 indicate that significant advantages are present for developing more positive attitudes toward science in all twelve classrooms where STS teaching strategies were used. The results of this study indicate that the STS approach improves more positive attitudes for nearly all students. The results for every grade level and for every teacher indicate significant positive changes in STS classrooms. Further, the reversals are more positive for females than they are for males. STS is seen as positive factor for removing the gender bias which is commonly reported favoring males in science. STS seems effective in reversing the trend from more negative attitudes developed over the years. And yet the more negative attitudes usually found occurred in the textbook-oriented classes. Such a finding is especially significant science the evidence is so overwhelming that typical instruction results in more negative attitudes at the end of the year when compared to the beginning and from grade to grade. This study shows that the

attitudes of students in STS sections are significantly better than for students in the textbook-oriented sections.

Previous research indicates that there are gender difference concerning achievement, attitude, and learning strategies in science, often favoring male students over female ones (Kenway & Gough 1998, Tsai, 2000). This study provides comparative data between males and females students as a result of STS instruction; significant differences were found in terms of gender issues in all of the comparisons. The results indicate that when students learn science by using the STS approach, they develop more meaningful learning and deeper understandings of learning and the teaching strategies that are needed to develop process skills and an organizational scheme for achieving scientific literacy. This study indicates that STS-based learning may be a potential way to narrow the gap between male and female students regarding more positive attitude toward science for both.

Attitude and creativity are called the enabling domains by Yager and McCormack (1989). In a real sense learning cannot occur in classrooms where science is not seen as fun, useful, and intriguing. STS is a reform effort that includes student interests, ideas, problems identification, and problem resolutions. Such student-centered efforts may provide the reason for such reversals of the negative attitudes so often found among all students as they progress across the K-16 continuum. Positive attitudes about science, science classes, science teachers, and scientists are worth major attention if the goals of most reform initiatives are to be achieved. Too often the job of the teacher is merely to present information to students while not focusing on or encouraging individual students. It is easy for too many teachers to blame students, parents, school administrators for “turned off” students.

Conclusions

1. Students in classes taught with an STS approach develop more positive attitudes toward science when compared to students in classes taught with a textbook-oriented approach
2. Male students in classes taught with an STS approach were able to develop more positive attitude toward science when compared to students in classes taught with a textbook-oriented approach.
3. Female students in classes taught with an STS approach were able to develop more positive attitude toward science when compared to students in classes taught with a textbook-oriented approach.

4. The STS approach to science teaching works equally well for male and female students concerning their attitudes toward science.
5. High ability students in classes taught with an STS approach develop more positive attitudes toward science when compared to students in classes taught with a textbook-oriented approach
6. Low-ability students in classes taught with an STS approach develop more positive attitudes toward science when compared to students in classes taught with a textbook-oriented approach.

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