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ABSTRACT

The purpose of this study was to identify and analyze changes in attitudes towards science in technology-based science content courses for K-8 preservice teachers at Black Hills State University and relate those attitudes to the predominantly female gender of the students enrolled in the class. Given an overwhelmingly female science classroom in which Internet research, hands-on science activities, cooperative group work, and a constructivist learning environment is promoted, this study investigates how women's attitudes towards science change before and after taking a technology-integrated class. This study also examines the relationship of technology to an effective and motivating science classroom. (KHR)

Black Hills State University

It Is a Gender Issue! Changes in Attitude Towards Science in a Technology Based K-8 Pre-service Preparation Science Classroom

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It Is a Gender Issue: Changes in Attitude Towards Science in a Technology Based K-8 Pre-service Preparation Science Classroom

Purpose of the Study

The purpose of this study was to identify and analyze changes in attitudes towards science in a technology based science content course for K-8 pre-service teachers at Black Hills State University, and to relate those attitudes to the predominantly female gender of the students enrolled in the class. Given a overwhelmingly female science classroom where Internet research, hands-on science activities, cooperative group work and a constructivist learning environment is promoted, it is essential to describe how young women's attitudes towards science change before and after taking a technology integrated class, for purposes of encouraging more K-8 teachers to teach science with an enthusiastic orientation and ultimately to encourage more young women to choose science careers. Since all teachers are being required to integrate much more technology than ever before into their teaching this research helps align instruction with that requirement while fulfilling content objectives. At the same time, science educators need to maintain a positive advance towards encouraging more women students become more literate and enthusiastic in science classes. A positive attitude towards different components of education in science can help a young woman maintain determination to succeed in a science-related career as she continues through the academic pipeline.

The other focus of this study is to examine the relationship of technology to an effective and motivating science classroom. The integration of technology has become a large addition to classroom teachers' daily pedagogical requirements. National and State Standards for Science Teaching require that students learn the differences in, and relationships of science and technology (South Dakota State Standards for Science and Technology[1]):

> "All students must recognize how developments in science impact their personal, societal, and physical environment and how scientific knowledge is developed, organized and interrelated. Scientifically and technologically literate people know how to apply the methods of science and technology for personal and professional growth and are able to use these skills for advancing community well-being."

[1] Found at URL http://www.state.sd.us/deca/TA/contentstand/Science/index.htm

Theoretical Underpinnings

In recent public school science classrooms, Skolnik, et. al, found that teachers pay more attention to and call on male students more than they do female students. These teachers ask higher-level questions of their male students than they do their female students, and allow the male students more time to compose answers to questions. Teachers interrupt female students more than male students. They address male students more frequently by name. Girls are more often praised for appearance or behavior, whereas boys are more often praised for performance. High achieving girls receive the least amount of the teacher's time in attention and in questioning.[2]

Shepardson and Pizzini[3] reviewed studies that showed that boys outperform girls in questions that relate to scientific ability. These authors suggest that the differential educational treatment of girls and boys discourages girls from participating in the classroom activities, which can develop their scientific abilities. Their study suggests that one reason for the differential educational treatment of girls and boys is that teachers possess a gender bias in their perception of the scientific ability of their students. Their study required teachers to complete the "Scientific Skills Inventory" for their students by listing their students' complete names, and by identifying what scientific skills they perceived each student possessing. Both lower and upper level elementary teachers perceived more girls to lack scientific skills and possess social skills compared to boys. The researchers interpreted responses to indicate that a gender bias exists in the perception of the scientific ability of students by female elementary teachers, consistent across grade level. The researchers point out that these results cannot be interpreted as having a cause of less scientific ability development in the girls, but rather suggest the possibility of differential educational treatment of the girls, resulting in the girls having less opportunity to develop their scientific ability. Girls are still being treated as stereotypically less able to achieve in advanced mathematics and physical sciences than are boys

Attitudes associated with science are reported to be affecting student participation in science as a subject[4] and impacting performance in science.[5] An international assessment of nine-and-thirteen-year-old students in

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[2] Skolnick, Langbort, and Day, 1982.
[3] Shepardson and Pizzini, 1992.
[4] AAAS, 1989; Koballa, Crawley, & Shrigley, 1990.
[5] IAEP, 1992; Weiss, 1987; Linn, 1992.

twenty countries (IAEP, 1992) revealed that positive attitudes toward science influence student performance. Positive student attitudes toward science were related to higher science performance by the majority of 13-year-old students in 15 countries.[6]

In previous research using the survey of attitude towards science with a pre-service elementary science classroom[7], Kruskal's Gammas were calculated for increase in positive attitudes towards science and science teaching before and after taking the technology based science content class. The question with the highest positive Gamma was that calculated for "I have a good feeling toward science." That Gamma, of value .437, indicated a very strong positive increase in feeling towards science after taking this class. Other questions with a large positive Gamma were: "I remember most of the things I learn in science class," "It makes me nervous to even think about doing science," and questions 35, 36, 7, 28, and 17; their Gamma values ranged from .26 to .437. Other questions that had positive Gamma's of more than .09 were those of numbers 1, 25, 26, 48, 41, 16, 19 20, 21, and 22. The Gammas representing analysis of questions number 12, 27, and 28 were so close to zero that it is not likely to have any significance.

In the previous study, the question that had the largest negative Gamma, indicating a notable decrease from before to after was number 4, "I do not do very well in science." This indicates that students in the class reported in that study developed a more positive self-concept in science as a result of taking the technology-integrated class.

> All students must recognize how developments in science impact their personal, societal, and physical environment and how scientific knowledge is developed, organized and interrelated. Scientifically and technologically literate people know how to apply the methods of science and technology for personal and professional growth and are able to use these skills for advancing community well being.

Science teaching for grades K-12 and beyond has developed hands on, experiential methods that have been effective without adding in the mix of technology, especially as it is interpreted by non-science education literate policy makers. Too often policy makers view technology as the use of computers in settings like the modern office – word processors, data base and spreadsheet fluency, and on a rare occasion,

[6] IAEP, 1992.
[7] Norby, R. 2002.

development of presentations in programs such as PowerPoint©. Many individuals[8] are pushing technology literacy for teachers and students, but the connection to improving attitudes towards science, perception of the science teacher, the value of science in society, and the enjoyment of science, has yet to be analyzed. Given the need for technology literate educated individuals in the workplace, it is important to provide technology based learning experiences in science classes. But hands-on science teachers have some real questions about the value of replacing class time spent in practicing the processes of science with computer and other technology based experiences.

Analysis

Fifty-five students in two four hour classes took the "Assessment Of Attitude Towards Science"[9] on the first day of the "ELED 303 – Earth and Physical Science for K-8 Teachers" in Fall 2001. The assessment was administered anonymously to two groups that consisted of fifty women and 5 males. The students spent 4 hours per week for 15 weeks in a university computer lab that provided one computer per student with Internet access, and with Microsoft Office, AppleWorks, and Inspiration installed on each computer. Students studied a science textbook outside of class, and completed project based activities in earth, space and physical sciences during class. Students used the Internet to research science content, lesson plans for K-8 teachers, and to access state and national science standards that include STS standards. The students took the post-assessment in the last week of the class.

Individual scores on the Likert scale were averaged for each question on the assessment and grouped by concepts for purpose of analysis. Percentages of responses -- pre and post -- were calculated for the groupings "strongly agree/ agree", "neutral", and "disagree/strongly disagree". The Percentage increase (see Appendix D for complete data report of percentages increase) on the group of questions referring to a positive perception of the science teacher increased more than any other grouping except the students' self concept of science. Anecdotal feedback from many students supported the idea that the students found the teacher approachable, supportive, and that she encouraged their experiences in learning science for K-8 students. This was the most desired outcome of the class, that young women who are going to be K-8

[8] Norby, R. 2002.
[9] Weinberg, M. 1998.

teachers have a more positive perception of themselves as being capable in science. Teachers cannot teach something effectively if we don't have confidence in ourselves that we know the content. The students in the class studied will remember the activities they completed in this class when they are required to teach science in their classrooms, and have strategies developed for learning new material, and developing and locating activities that will help their students master higher level learning in science.

Data were also analyzed using SPSS© Crosstabs to identify Gamma and Pearson's correlation coefficient for ordinal data. Contingency tables, generated by the SPSS procedure: CROSSTABS, were used to obtain a Gamma (G), known as Goodman and Kruskal's Gamma, a symmetric measure of association for ordinal-level data in this questionnaire.

Gamma can range from +1.00 to –1.00.[10] A Gamma of 0.00 implies no relationship between the variables. When the value of Gamma is between 0.00 and 1.00, an increasing amount of direct relationship between the variables can be interpreted, depending how close Gamma is to the value 1.00. When the value of Gamma is between 0.00 and –1.00, an increasing amount of inverse relationship between the variables can be interpreted. "Gamma is the most frequently used measure of association for ordinal-level and interval-level data." (Elifson, et. al., 1982) Gamma was computed for the change in value on a Likert scale of each question (See Appendix A for list of questions asked) before and after taking the class, in order to ascertain whether there was any change – pre and post – in attitudes. The attitudes were grouped into six groups:

- **Perception of the Science Teacher**
- **Anxiety toward Science**
- **Value of Science in Society**
- **Self-concept of Science**
- **Enjoyment of Science**
- **Motivation in Science**

Some statements were worded in the negative indicates that the score will be reversed. Higher numerical scores reflect more position attitudes in all area except anxiety where a lower numerical score reflects a more positive attitude (less anxiety).

[10] Norby, 1999.

Appendix A gives the list of questions with their Gamma values between each question asked before and after taking the class.

None of the grouped questions had Gammas showing changes larger in magnitude than 0.15. Although the individual analysis of percentage changes shows the expected improvement in attitudes, when Gammas are grouped the variation on item questions averages out.

Analysis

The students were pre-service teachers so it would be expected that they already had a fairly positive perception of science teachers. On a formative assessment at the beginning of the semester that asked the students about their most positive experience in science learning, almost all of the individuals who responded to this question described hands-on activities and an enthusiastic science teacher. When asked about the least positive experience in science learning, the respondents listed such items as a teacher too busy to answer questions, too much lecture, balancing equations in high school chemistry, and dissecting a frog or a fish. Now that there are internet sites that allow frog dissection without the odor and the intimate contact with dead, preserved tissue, we can plan that all students who find this part of biological science learning distasteful will develop are more positive attitude on the topic.[11] The results of data collection showed that, for this group of students, use of technology in this class produced important increases in feelings of motivation, positive self-concept as a learner, and enthusiasm about science. In Appendix B, the averages of pre and post scores are given with the differences before and after. On the group of questions pertaining to the value of science in society, students did not, for the most part, change in their perspective on this topic. More students agreed and strongly agreed on this topic on the pre and post assessments.

For the group related to perception of the science teacher, on questions 1 and 4, there was a notable increase in positive attitude towards the science teacher. The combination of a teacher emphasizing herself in the role of the "guide on the side" with the use of technology in the classroom improved the students' attitudes measurably in this classroom.

For the group of questions related to anxiety towards science, there was a decrease in anxiety equivalent to half the distance between data points for the respondents in this classroom. For the group of

[11]See http://www.froguts.com/

questions related to enjoyment of science, the students were definitely more aware of their enjoyment of science after this classroom experience.

Motivation in science was a group of responses where the students' attitudes changed very slightly. The change was to an increase in motivation, but only a very slight amount. Students were already moderately motivated to learn science at the beginning of the semester, so those results may show that the motivation was as high as can be expected, given the many claims on the time of Junior level elementary education majors.

Conclusions

Students need to learn the content as well as developing more positive attitude towards their own abilities to be effective in science. Verification exists that the students in this class have become knowledgeable of the content through the variety of assessments used:

- Reflective journal entries
- Written assignments describing content learned
- Write-ups of hands-on science activities
- using the scientific method in presenting science research projects
- development of models representing important concept in earth, physical and space science
- small group discussions of science content correlated to state science standards
- jigsaw reading of text book chapters with presentation by small groups
- Internet research to locate grade specific lesson plans with class demonstrations of lesson plan activities

Student formulated questions about science became more frequent as the semester progressed and the level of the questions developed from simple recall level to questions requiring analysis and application of previously learned concepts as the semester progressed and students became more comfortable in the non-judgmental atmosphere of the class.

For a comparative study, further research with similar classrooms that are taught without the presence of extensive access to technology could demonstrate the importance of integration of technology into science teaching for K-8 teachers for improving women teachers' self-concept in science..

Implications for Classroom Teachers

It is a truism that most of the individuals who enroll in elementary education majors are young women.[12] The character of elementary schools is predominantly female teachers, with males often present only as principals. This configuration has changed very little since the 1950's. A thorough scanning of the faces in any class required for elementary education majors at a teacher preparation college will confirm the perception that many more women choose careers as elementary teachers than do men.

The negative experiences that these women have had in elementary and secondary school (Skolnick, et. al., 1982) to a great extent has turned them off to science and convinced them that they cannot be successful in a science learning classroom. How can we expect these young women to teach the science required in 21st century classrooms with that sort of attitude? Appendix C gives answers given by individuals in the classes researched to the question " What was your least enjoyable experience in a science classroom?"

Kahle[13] showed that having effective and girl-friendly" teachers in a secondary science classroom can give young women the confidence and knowledge needed to be knowledgeable scientists, and the researcher for this study intends to recommend implementation of technology based, gender friendly lessons for young women in science classes, at the post-secondary level.

Activities in this hands-on, learner-centered classroom were designed to give teachers knowledge of science content knowledge that will support the level of science they will be teaching. An outline of topics for hands-on activities for pre-certification teachers and suggested relevant science teaching standards is provided to the students at the beginning of the semester. Emphasis of connecting to national and state science standards is routine in this course.

Results of this research should encourage and inspire classroom teachers to use technology and Internet access in the classrooms for other purposes than record keeping and word processing. The classroom where students are responsible for locating and processing information, given time and autonomy to research in a fashion that suits their learning style, encourages them to be more informed and enthusiastic science

[12] Personal communication, Dr. Jack Hassard.
[13] Kahle, J.B. 1985.

teachers. Most importantly for this research, female teachers can acquire greater confidence in their abilities to communicate science and to "do" science, which is necessary to provide effective science teaching in K-8 classes. The students in this research study improved their own confidence in understanding science, had a better attitude about teaching science, and can be expected to model enthusiasm for science for their students, both male and female. Gender bias towards women in science begins early in school, and having effective positive female teachers can counter the uniform prevalence of gender bias, early and often.

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Appendix A

Gammas Between Questions on Pre and Post Assessment of Attitude Towards Science

Relationship of Pre or Post with each Question

Analysis Using Gamma sorted by Value of Gamma

Question Asked	Gamma
46. Science teachers do not like students to ask questions.	0.113
31. Science teachers do not seem to enjoy teaching science.	0.107
14. Sometimes I read ahead in our science book.	0.086
I want to improve my attitude towards science in this class	0.086
32. I like the challenge of science assignments.	0.061
13. I would like to spend less time in school studying science.	0.039
48. If I don't see how to do a science assignment right away, I never get it.	0.039
22. I often think, "I cannot do this," when a science assignment seems hard.	0.018
42. It is important to me to understand the work I do in the science class.	0.017
4. I do not do very well in science.	0.013
38. Most of the ideas in science are not very useful.	0.001
5. Science teachers show little interest in the students.	-0.006
25. It does not disturb me to do science assignments.	-0.021
39. It scares me to have to take a science class.	-0.021
33. You can get along perfectly well in everyday life without science.	-0.022
24. It is important to know science in order to get a good job.	-0.023
28. I enjoy talking to other people about science.	-0.026
37. I would rather be told scientific facts than find them out from experiments.	-0.026
47. I have a real desire to learn science.	-0.026
43. I have a good feeling toward science.	-0.032
45. Science is one of my favorite subjects.	-0.038
9. There is little need for science in most of today's jobs.	-0.044
29. I do enjoy watching a science program on television.	-0.048
2. Science is something which I enjoy very much.	-0.053
16. I usually understand what we are talking about in science.	-0.056
3. I like the easy science assignments best.	-0.059
12. Most people should study some science.	-0.063
41. The only reason I am taking science is because I have to.	-0.069
36. It makes me nervous to even think about doing science.	-0.083
23. Science is of great importance to a country's development.	-0.084
30. I am good at working science labs and hands-on activities.	-0.085
10. Science is easy for me.	-0.086
7. I feel at ease in a science class.	-0.092
26. I would like a job, which does not use any science.	-0.093
21. Science teachers present materials in a clear way.	-0.103
18. I do not like anything about science.	-0.104
35. I remember most of the things I learn in science class.	-0.116
27. Science teachers know when we are having trouble with our assignments.	-0.118
34. Working with science upsets me.	-0.133
8. I would like to do some outside reading in science.	-0.149

Appendix A – continued Relationship of Pre or Post with each Question	
40. Science teachers are willing to give us individual help.	-0.15
20. I feel tense when someone talks to me about science.	-0.151
19. No matter how hard I try, I cannot understand science.	-0.161
11. When I hear the word "science," I have a feeling of dislike.	-0.177
44. Science teachers know a lot about science.	-0.177
15. Science is helpful in understanding today's world.	-0.209
17. Science teachers make science interesting.	-0.213
1. Science is useful for the problems of everyday life.	-0.281
6. Doing science labs or hands-on activities is fun.	-0.284

Appendix B

Changes in Responses to Questions from Pre to Post

POST Fa 01	PRE Fall 01	Difference (Post - Pre)	Question #
1.78	2.07	-0.29	1
2.93	2.87	0.06	2
2.26	2.07	0.19	3
3.26	2.67	0.59	4
4.00	3.67	0.33	5
1.26	1.50	-0.24	6
2.78	3.40	-0.62	7
3.37	3.30	0.07	8
3.96	4.03	-0.07	9
3.33	3.67	-0.33	10
3.30	3.07	0.23	11
1.70	2.07	-0.36	12
3.07	3.07	0.01	13
4.11	4.27	-0.16	14
1.89	2.20	-0.31	15
2.44	3.07	-0.62	16
2.52	3.27	-0.75	17
3.67	4.53	-0.87	18
3.48	4.17	-0.69	19
3.48	3.97	-0.49	20
3.00	3.70	-0.70	21
2.89	3.47	-0.58	22
1.85	2.47	-0.61	23
2.93	3.57	-0.64	24
2.59	3.60	-1.01	25
2.81	3.77	-0.95	26
3.19	3.70	-0.51	27

APPENDIX B Continued

POST Fa 01	PRE Fall 01	Difference (Post - Pre)	Question #
3.22	4.33	-1.11	28
2.93	3.67	-0.74	29
2.00	3.03	-1.03	30
3.52	4.53	-1.01	31
3.04	4.13	-1.10	32
3.74	4.57	-0.83	33
3.56	4.63	-1.08	34
2.85	4.50	-1.65	35
3.37	4.77	-1.40	36
3.93	5.13	-1.21	37
3.78	5.03	-1.26	38
3.30	4.27	-0.97	39
2.44	3.73	-1.29	40
1.96	3.60	-1.64	41
2.11	3.27	-1.16	42
2.63	4.50	-1.87	43
2.00	3.40	-1.40	44
3.56	5.07	-1.51	45
3.81	5.37	-1.55	46
3.07	4.60	-1.53	47
3.19	4.83	-1.65	48
2.67*			49

*Question only asked on the posttest.

Appendix C

Student Responses at Beginning of Class when Asked about Least Enjoyable Experience in Learning Science

Least Enjoyable Experience in Learning Science

disecting(sic) a frog
Teacher too busy
Bunsen burner
Dissecting a fish
Biology lecture
Losing paperwork
Biology class-crammed info, didn't learn
Microscopes
Teacher who avoided discussing science
When professor talks without teaching
Biology I in college
High School Biology
High School Chemistry equations
Having 4 different Biology teachers in one year
High School Chemistry--impatient teacher
Pure lecture
High School Chemistry
High School Physical Science
Biology 101
Middle School Science
Not understanding
Dropping mercury thermometer

Appendix D
Percentage Changes in Responses – Post Minus Pre

Group #	Positive (Grouped) Responses			Negative (Reversed) Responses		
	Strongly Agree/Agree	Neutral	Disagree /Strongly Disagree	Strongly Agree/Agree	Neutral	Disagree /Strongly Disagree
1	8.05%	-9.51%	0.69%	5.31%	-10.84%	4.89%
2	2.90%	2.28%	-5.18%	2.17%	-1.84%	-0.33%
3	1.36%	-1.14%	-0.21%	3.69%	-5.59%	1.90%
4	11.47%	-1.83%	-9.64%	-2.03%	5.23%	-3.20%
5	1.79%	-0.28%	-1.50%	4.33%	-3.15%	-1.18%
6	-0.74%	-0.57%	1.31%	2.46%	-3.86%	0.18%

Correlation of Concept Grouping With Question Numbers From TOAS

Perception of the Science Teacher = 5*, 17, 21,27, 31*, 40, 44, 46*
Anxiety toward Science = 7*, 11, 20, 25*, 34, 36, 39, 43*
Value of Science in Society = 1, 9*, 12, 15, 23, 24, 33, 38*
Self-concept of Science = 4*, 10, 16, 19*, 22*, 30, 35, 48*
Enjoyment of Science = 2, 6, 13*, 18*, 26*, 28, 29, 45
Motivation in Science = 3*, 8, 14, 32, 37*, 41*, 42, 47

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