Science-Related Attitudes and Effort in the Use of Educational Software by High School Students

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Abstract

The study investigated whether science-related attitudes can help predict the amount of effort put forth by high school students while using an educational computer science program. The study also looked at whether a student's science-related attitudes would become more positive after completing the program. Participants included 26 female high school students who completed the Test of Science-Related Attitudes (TOSRA) before and after the completion of the program. The results indicated that attitude and effort are positively correlated. The finding is congruent with the idea that science-related attitudes can help predict amount of effort put forth by high school students. Also found was that science-related attitudes did not significantly differ before and after the completion of the program.

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Every teacher desires students who are motivated to learn. Students who are motivated to learn participate in learning activities, stay engaged in a learning task, and show a commitment to learning. These characteristics help students to create goals and beliefs that play an essential part in maintaining a long-term relationship with learning (McCown, Driscoll, & Roop, 1996). However, before a student can learn anything, the student must put forth effort. The student must actually work in order to learn (Wong & Wong, 1991).

From this perspective, it is important to try to understand students' efforts and motivations in a classroom. Effort put forth by a student is important in understanding a student's achievement and success in school. Research examining time spent on task comparing Asians and non-Asians has shown remarkable differences. Harold Stevenson, a University of Michigan psychology professor, concluded after a six-year study on time on task that they "did not find any difference in IQ levels, but . . . found significant differences in performance" (Wong & Wong, 1991, p. 201). In the study he found that an American first-grade student spends an average of 14 minutes a night on homework and hates it, in comparison to a Chinese first-grade student (in China) who spends an average of 77 minutes a night on homework and likes it (Wong & Wong, 1991). Apparently, American students are not as motivated in school as Asian students in some countries. Research on how to predict student effort can help in accomplishing the goal of higher achievement in students.

Do students put forth more effort into subject-related tasks if they find the subject to be interesting? Little research has been done examining how a student's attitude towards a subject can affect the amount of effort put into a computer learning task. There are relatively few studies on whether a student's attitude towards a subject can affect the amount of effort put into a task while using a computer.

Science is a basic subject in practically all schools. Do students find science interesting? A recent survey by the Bayer Corporation and the National Science Foundation challenged the idea that science is boring and uninteresting. The survey found that nearly fifty percent of the students asked ranked science at or close to the top of their list of classes they liked the most (Henry, 1997). Even though science may be seen in a more positive manner than in past years, there is still a need to determine whether a student's attitude towards science can affect the amount of effort put into a cooperative computer task. Therefore, the first goal of the study relates to attitudes and effort. The first goal is to determine to what extent science-related attitudes predict effort in high school students while using an educational science software computer program.

If students are given the chance to learn science material in a different, challenging manner, will this change their views towards science? Science educators have recently been supporting an approach to learning science where the students are able to build scientific knowledge by solving real, meaningful science problems (Stratford & Finkel, 1996). In this study, students use a challenging multimedia computer program called BioBLAST (Better Learning through Adventure, Simulation, and Telecommunications). BioBLAST enables the students to engage in solving real life problems faced by the National Aeronautics and Space Administration (NASA). The program is designed to get the students thinking individually and as a group. Therefore, the second goal of the study is to determine whether the use of the program helps change students' attitudes after the program is complete.

Attitude and Behavior

Can science-related attitudes predict effort in students who are using an educational software computer program? One concern of researchers in science education today is whether science attitude scores can predict science behaviors in the classroom (Shrigley, 1990). The relationship between attitudes and behavior has long been debated, dating back to the 1800s when "attitude was behavior" (Shrigely, 1990, p. 99). Attitude and behavior relationships have taken a long journey through psychological history: first thought to be consistent, then inconsistent, and finally correlates (Shrigley, 1990).

Shrigley attempted to determine if science attitude scores can reflect science behaviors in the classroom by examining different attitude-behavior relationships. He examined the problem from five points of view: attitude precedes behavior, attitude is behavior, attitude is not directly related to behavior, attitude follows behavior, and attitude and behavior are reciprocal. Shrigley (1990) concluded that the research that had been done up to that point showed that science attitude scores were moderately correlated to science behavior.

Shrigley's (1990) review of the research on science attitudes and behavior showed that science attitude scores can possibly predict science behaviors. Positive science behaviors should show an interest in science and science learning. Students should be given the opportunity to try to improve their science-related attitudes if improvement is needed. Shrigley's findings that attitude scores can possibly predict science behaviors led to my first hypothesis: Students with a positive attitude towards science will show higher levels of effort during computer use.

Using Computers to Improve Science Attitudes

In one study a school system chose to experiment with a new approach in teaching biology in order to try to create more positive attitudes towards science and science instruction. The study enabled students to use microcomputers in order to "expand, enrich, reconstruct, and supplement the laboratory and lecture components of the traditional biology course" (Hounshell & Hill, 1989, p. 543). Through microcomputer use, students were able to do experiments that were impossible or impractical to carry out in any other way. In particular the authors wanted to investigate whether there were a differences in attitudes towards science and the science course between students exposed to a computer-simulated program and students in a traditional biology course. Researchers found that students who engaged in the computer-simulated program scored higher on two science attitude inventories. Overall, the study showed that computer use in the classroom can improve attitudes of high school biology students. In addition, the computer program in the study demonstrated promise in relation to helping make science attitudes more positive in students through the use of technological advances (Hounshell & Hill, 1989).

Another study focused on changes in students' ideas about science classes, attitudes about science, and motivations for studying science in a project-based curriculum (Stratford & Finkel, 1996). A project-based curriculum geared towards learning science is where students are given the chance to actively create scientific knowledge through participating in solving real, meaningful science problems. This approach allowed students to use computers and other technological tools where the formation of knowledge can take place. Specifically the study compared attitude changes of students in a traditional biology course with students in a project-based science course that had access to technological tools. The study found that allowing students to collect their own data, draw conclusions, and formulate and solve problems helped to change their attitudes about science classrooms. Although there were no significant differences found in attitudes toward science between the two groups, factors such as insufficient time could have been a reason why no significant differences were found (Stratford & Finkel, 1996). As a result, the second hypothesis is based on these findings: It is expected that students in the current study will show improvements in their attitudes towards science after completing BioBLAST.

Summary of Hypotheses

The hypotheses of the study are

1. Students with a positive attitude towards science will show higher levels of effort during computer use.
2. Students' attitudes towards science will become more positive after completing the program.

Method

Participants

Research participants included 26 female high school biology students enrolled at an all-female, Catholic academy. The students were in grades nine and eleven.

A packet was sent home with students to their parents explaining BioBLAST and the specific terms of the research study. The consent form in the packet notified the students and parents that the research would in no way affect the student's grade, that confidentiality would be kept, and that the student could choose to drop out of the research at any time. The students were required to do BioBLAST for their biology class, but the research participation was voluntary.

Procedure

The students' sessions with BioBLAST took place in the Cooperative Learning Center in the

NASA Classroom of the Future (COTF) on the campus of Wheeling jesuit University, Wheeling, WV. The students worked in groups of two or three around a computer. The teacher assigned the students to specific groups, which they remained in throughout the program.

The Test of Science-Related Attitudes (TOSRA) was handed out to the students at their high school a week before they began the program. It took the students approximately 15 minutes to fill out the TOSRA. The test was also given to the students when they completed the program. The program lasted a total of four weeks. A group evaluation sheet used to measure effort was given to students at the end of each week after the activities for the day were complete.

Materials

BioBLAST. The study is part of a larger project that is being conducted by the NASA COTF located at Wheeling Jesuit University. The project is examining student use of an educational software program called BioBLAST. BioBLAST is a biology curriculum supplement that "engages students in exploration of the interrelatedness of all living things" (Ruberg, 1997, p. 1). Students work in groups of two or three around a computer trying to solve real-life problems faced by NASA. The students participated in BioBLAST four days a week, an hour each day.

Science-Related Attitudes. The TOSRA (Appendix A), originally developed by Fraser (1978), was used to measure attitudes. The TOSRA was modified by Smist, Archambault, & Owen to include six factor subscales with a total of 70 items. The TOSRA underwent a validation study and these six factors were developed by the researchers. Smist et al. (1994) eliminated nine items (2,8,11,18,25,53,54,60,68) from the subscales and the analysis. Therefore, in this study, these items were also eliminated from analysis.

The test includes six subscales that measure science-related attitudes. The students rated the statements on a scale of strongly disagree (1) to strongly agree (5). The first factor is attitude toward science/career and leisure. An example of a question measuring the first factor was: "When I leave school, I would like to work with people who make discoveries in science." The second subscale is preference for experimentation; an example was: "It is better to ask the teacher the answer than to find out by doing an experiment." Social importance of science is the third subscale. One example of this type of question was: The government should spend more money on scientific research." The fourth subscale is normality of scientists. An example of this type of question was: "Scientists are less friendly than other people." Attitude toward science classes is the fifth subscale of the TOSRA; an example was: "Science classes are fun." The final subscale is openness to new ideas. An example was: "I dislike listening to other people's opinions." See Appendix A for the complete test. The mean scores for each subscale were calculated, in addition to an overall mean attitude variable that was used.

Student Effort. The measurement that was used to assess effort was a group evaluation sheet developed by COTF (Howard, 1997) (Appendix B). Each student working on the project individually rated herself and the other member in her group. The ratings from the group member and the self-evaluations were combined to get an average for effort. The evaluation sheet contained seven statements that related to contribution of the group member. An example of a statement was: "Helped to develop group ideas." See Appendix B for the complete evaluation sheet. For the evaluation sheet, a scale of 1 to 5 indicated, respectively, contributed very little, contributed little, average, contributed some, and contributed very much.

Results

A correlational analysis was used to analyze the data for the first hypothesis. There was a significant correlation between science-related attitudes and effort,

r (24) = .58, $p < .01$. As shown in Table 1, effort was significantly correlated with each of the subscales of the TOSRA except Normality of Scientists.

A paired sample t-test was used to determine whether there was a difference in attitudes before and after the program. There was no significant difference between overall science-related attitudes before the start of the program (M = 3.11, SD = .54) and after the completion of the program (M = 3.08, SD = .43), t (22) = .51, $p > .05$. Table 2 shows the mean scores of overall attitude and the six subscales before and after the program. There were no significant changes in attitudes for the subscales except in the "Attitude toward Science Classes" subscale, which decreased following the program. There was a significant difference in this subscale between attitudes before (M = 2.73, SD = .96) and after the program (M = 2.49, SD = .85), t (22) = -2.01, $p < .05$.

Discussion

A significant difference was found between science-related attitudes and effort, just as the first hypothesis had predicted–students with a positive attitude towards science would show higher levels of effort during computer use. However, there was no significant difference between science-related attitudes before and after the program. This result did not support the second hypothesis, which stated that attitudes would become more positive after students completed the program.

The outcome supports Shrigley’s (1990) belief that science attitude scores are correlated with science behaviors in the classroom. The study indicates that science-related attitudes can help predict science behavior in school settings. This particular study could be useful to educators who are trying to improve classroom motivation. Improving a student’s attitude towards a subject can help that student achieve higher success and achievment in school. Getting students to put forth more effort in subject-related tasks is a very important part of learning. Attitude scores that can help predict this effort should also be important in the educational setting.

The second outcome did not occur as expected. There was no significant difference between science-related attitudes before and after the program, an outcome that differed from past research findings. This suggests that the BioBLAST program was not effective in changing students’ attitudes towards science. However, since other researchers have found that these types of computer programs generally improve attitudes (Hounshell & Hill, 1989; Stratford & Finkel, 1996), perhaps other explanations could account for the findings. One reason could be a weakness in the design of the study. Unfortunately, only twenty-six subjects participated in the study, resulting in a small sample size. In addition, males were not included in the study. In order to try to compensate for the small sample size, using matched samples could have resulted in significant findings. A second reason could be that the time period of BioBLAST (4 weeks) was not long enough to cause a drastic change in attitudes. Longer duration of the program could possibly have had a bigger impact on attitudes. Another reason may be due to the instrument used. TOSRA is a 70-item inventory, which may be too repetitious and too long for high school students. A shorter inventory may have helped overcome any problems with repetition. In regards to content, the TOSRA measured science attitudes in general; an inventory geared directly towards biology attitudes would be more precise and more helpful in a program like BioBLAST. A fourth possible explanation may be that the students did not relate well to the instructor who was presenting BioBLAST. It is possible the students did not understand the teaching style of the instructor and was not able to adjust to it within the short time period. It is also a possiblity that the time period between the completion of BioBLAST and the post-test measures was not long enough. Maybe if the measures were handed out a month or two after it would have a bigger effect on attitudes. Additional research is needed to test these possible explanations of why the second hypothesis did not come out as predicted.

Future research might extend the findings by examining gender differences of attitudes and efforts. Only female subjects were used in the study, and future research should include males. It would be interesting to see if gender and age differences have an effect on science-related attitudes and effort. Males and females differ in their attitudes towards science (Smist et al., 1994), and research trying to help determine how to get more females involved in science-related careers would be beneficial to the female population. According to Smist et al. (1994), more males go into the science-related careers, and future research on how to improve female’s attitudes towards science could help overcome the shortage of their numbers. Although the research by Smist et al. is a few years old, it is still important in trying to understand why students pick the careers they do. Age and gender differences in science attitudes would be interesting to study in order to see whether they affect student motivation and achievement in a classroom, especially while using educational software such as BioBLAST. The educational and technological worlds can provide the tools and knowledge required to achieve a thriving learning environment for all students.

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Table 1

Intercorrelations Between

Subscales, Science-Related Attitudes, and Effort

Variable	1	2	3	4	5	6	7	8
1. Effort		**.58***	.55**	.68**	.45*	.18	.39*	.52**
2. Attitude			.94**	.90**	.73**	.50**	.90**	.76**
3. Career				.80**	.72**	.31	.89**	.60**
4. PFE					.59**	.37*	.72**	.71**
5. Soc Imp.						.40*	.53**	.40*
6. Normal							.33	.31
7. Sci. Class								.59**
8. Open								

Note. *$p < .05$ (1-tailed). **$p < .01$ (1-tailed).

Note. Subscales are from TOSRA: Career = Attitude toward Science/Career and Leisure; PFE=Preference for Experimentation; Soc. Imp.= Social Importance of Science; Normal= Normality of Scientists; Sci. Class= Attitude toward Science Classes; and Open= Openness to New Ideas.

Table 2

Mean Scores of Attitudes Before and After Program

Attitude (n = 22)	Before	After	Difference
Overall Attitude			
M	3.11	3.08	.03
SD	.54	.43	
Attitude toward Science/Career and Leisure			
M	2.52	2.66	.14
SD	.82	.63	
Preference for Experimentation			
M	3.13	3.17	.04
SD	.77	.79	
Social Importance of Science			
M	3.44	3.41	.03
SD	.44	.45	
Normality of Scientists			
M	3.49	3.55	.06
SD	.35	.44	

Attitude toward Science Classes

M 2.73 2.49 .24*

SD .96 .85

Openness to New Ideas

M 3.35 3.23 .12

SD .58 .44

* significant at .05 level