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ABSTRACT

Current research shows that the number of science fairs and science fair participants is increasing. However, other than the growth of participant numbers, there is very little research investigating the benefits of these science fairs and assessing whether science fair projects are worth the time, effort, and money spent on them. The purpose of this study was to explore the impact of science fairs on students' understanding of scientific method and attitudes towards science. Seventh grade students were selected from four schools, which spanned a wide socioeconomic range and varied in whether or not students participated in a science fair. Two questionnaires were developed for this study, one to measure the understanding of scientific method and the other to measure attitudes toward science. A pretest posttest control design was used. Four hundred three students (201 females and 202 males) took the pretest, and four hundred fifty-six students (214 females and males) took the posttest. The experimental group was chosen from schools where participation in the science fair was obligatory. The control group was chosen from schools that didn't hold a science fair. Pretests were given at the beginning of the science class and posttests were given after the science fair. T-tests were used for data analyses of the pretest and posttest results. The results were not statistically significant when the scientific method scores and attitude toward science scores were compared between control and experimental groups. Gender was found to be significant. In the pretest, girls exhibited higher scientific method scores than boys. The pretest scientific method scores dropped for both genders in the posttest. However, this drop was similar between genders. In contrast, males who participated in the science fair had higher attitude toward science test scores before the science fair, yet attitude scores were nearly equal for both genders after the science fair. (Author)

The Impact of Involvement In A Science Fair On Seventh Grade Students

by

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Abstract

Current research shows that the number of science fairs and science fair participants is increasing. However, other than the growth of participant numbers, there is very little research investigating the benefits of these science fairs and assessing whether science fair projects are worth the time, effort, and money spent on them. The purpose of this study was to explore the impact of science fairs on students' understanding of scientific method and attitudes towards science. Seventh grade students were selected from four schools, which spanned a wide socioeconomic range and varied in whether or not students participated in a science fair. Two questionnaires were developed for this study, one to measure the understanding of scientific method and the other to measure attitudes toward science. A pretest/posttest control design was used. Four hundred three students (201 females and 202 males) took the pretest, and four hundred fifty-six students (214 females and males) took the posttest. The experimental group was chosen from schools where participation in the science fair was obligatory. The control group was chosen from schools that didn't hold a science fair. Pretests were given at the beginning of the science class and posttests were given after the science fair. T-tests were used for data analyses of the pretest and posttest results. The results were not statistically significant when the scientific method scores and attitude toward science scores were compared between control and experimental groups. Gender was found to be significant. In the pretest, girls exhibited higher scientific method scores than boys. The pretest scientific method scores dropped for both genders in the posttest. However, this drop was similar between genders. In contrast, males who participated in the science fair had higher attitude toward science test scores before the science fair, yet attitude scores were nearly equal for both genders after the science fair.

The Impact of Involvement In A Science Fair On Seventh Grade Students

Currently, organizations and institutions expend a great deal of resources on science fairs. Many educators believe that involvement in a science fair is one of the best ways to develop the skills, attitudes and knowledge that will lead to a successful carrier in the future (Czerniak, 1996). According to Bruce and Bruce (2000), the most common reason that children became interested in science is an experience in a science fair. Also, in a survey of science fair participants, most students agree that the science fair is fun and that they learn new things in the science fair (Abernathy & Vineyard, 2001). Most teachers believe that student science projects meet the educational goals of science as recommended in the American Association for the Advancement of Science and the National Science Teachers Association (Schneider & Lumpe, 1996). Grote (1995) also found that teachers think that science projects teach students about scientific method and promote their interest in science. Some universities and corporations spend a lot of money, time, and effort sponsoring science fairs, providing professional scientists to mentor students or judge the projects, and awarding prizes and scholarships for the winners. Science fairs build partnerships between K-12 schools and universities, organizations, and corporations. These partnerships enable students to work in scientists' laboratories, hospitals, and university laboratories. According to Sherburne (as cited in Huler, 1991), the 1991Science Service president, by working at actual labs, students learn things that they don't learn in the class. According to Huler (1991) and Marsa (1993), the students who enter the Westinghouse Talent Search frequently pursue careers in science and become the best in their fields. In addition, Wiygul & Gifford (1987) found that students who have access to university and other facilities had a better chance of winning at Mississippi Region V science fair.

Many articles report positive and supportive attitudes towards science fairs. However, researchers generally agree that most of the articles written about the effectiveness of science fairs are based on opinion rather than research (Abernathy & Vineyard, 2001; Carlisle & Deeter, 1989; Czerniak, 1996; Schneider& Lumpe, 1996; Slisz, 1989). Also, most of the research studies are based on higher-level (3rd to 6th level) science fairs, where high achiever, competitive, and successful students participate (see Figure 1). Because these science fair participants are usually elected from the winners of the former science fairs, the participants hold higher science aptitude and attitude. Research studies with students with low science aptitude and attitude might be contrasting. As 1st and/or 2nd level of science fair applies to the most students, at all levels, more research is needed in this area.

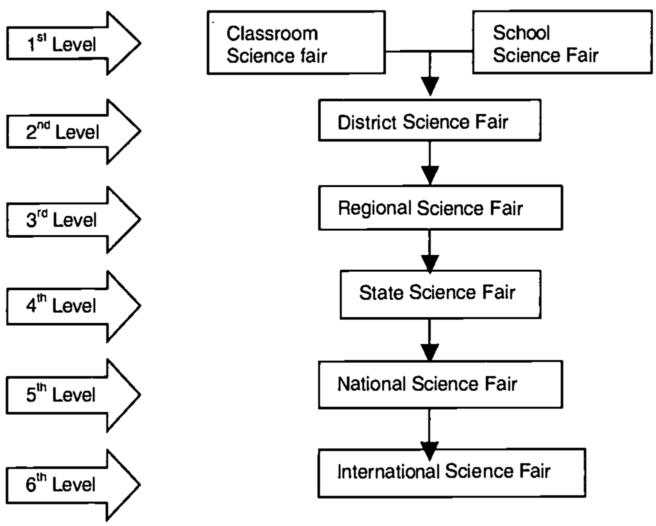

Figure 1. Different Levels of Science Fairs

In the research on preservice teachers' attitudes to their past science fair experiences, Bunderson and Anderson (1996) conclude that science fairs have not always been successful in promoting the goals attributed to them. According to Carlisle and Deeter (1989), "many teachers support the fair as an academic competition that provides challenges and rewards for able students" (p.25). While this may sound good, rewarding some students leaves others (the losers) without reward. Chiappetta and Foots (1984) indicate that science fairs can disappoint many students as very few win prizes at the competition. Science fairs can encourage and reward excellence for some students, but they may not do much for students who are not particularly gifted or competitive (Burch, 1983). The issue of equal opportunity in science fairs has been a concern in most research. Judging of the students' projects and the effect of competition during science fairs are discussed in the literature.

Judging and Competition At Science Fairs

Assessing project-based learning is a very complex process, as it requires the assessment of not only the knowledge of science concepts and science content but also the physical and mental processes used in each type of investigation. The reliability and validity of project assessments at science fairs depend on the appropriateness of criteria or the rubric and the quality of judges.

A typical judging rubric in science fairs could be based on five main criteria; a) creative ability, b) scientific thought and/or engineering goals, c) thoroughness of work, d) skill and clarity of display, and e) teamwork for team projects. Judges use these criteria to determine the quality of students' work by gathering evidence whether each criterion is met (Diez & Moon, 1992). According to Bellibanni & Lilly (1999), the judging criteria are not enough for evaluation.

Project –based assessment requires very good judging skills. Judges, who are chosen from volunteers, are one of the main and most important parts of a science fair. According to Edelman (1988) (as cited in Bellipanni and Lilly, 1999), the best approach is, if possible, choosing the judges by and from the scientific personnel (e.g. local college or university science faculty, science-related business or local organizations). Instruction on how to review the projects and interview the students should be provided to the people who will do judging in a science fair (Bellibanni & Lilly, 1999).

Many researchers argue against the competitive aspect of science fairs. The fairness of science fairs for all participants has been investigated through comparing the characteristics of the winners and non-winners. Jackson (1995) found that all students don't have an equal chance of winning in science fairs. Based on current research, the characteristics of the winners of science fairs significantly differ from the non-winners. Four main factors contributing to these differences were drawn from the literature. These factors include use of outside resources and easy access to the resources, parental occupational class, direct cost of projects, and compulsory vs. voluntary participation.

According to Carlisle and Deeter (1989), "many teachers support the fair as an academic competition that provides challenges and rewards for able students" (p. 25). Although competition can be used as a motivational factor in some science activities, it might not be beneficial to all students. The competitive aspect of science fairs seems to be a concern in most of the research and even can detract from the goals of science fairs (Chiapetta & Foots, 1984). Competition may cause extreme ambition leading to anxiety and pressure. The expectation of parents and teachers for their children can also increase the degree of pressure because parents and teachers want their children be the winner. Sometimes, science fair participation can be counted as a science course grade or one of the grades for the course (Czerniak, 1996). Grading the result of a science fair in the classroom also puts additional pressure on students because students must do well in the science fair to get a good grade at school. According to Spielberger (1966) (as cited in Czerniak, 1996), even though anxiety can enhance learning in high ability students during complex learning tasks, this may not hold true for female and for the very young.

Research mostly concludes that the effect of competition differs for girls and boys. Females have lower confidence and expectancy of success when competing than when working alone (Silvestri, 1990). Even during pre-school, the play preferences of girls and boys are different (Blum, 1999). Boys tend to gather in larger, competitive groups and play games that have clear winners and losers. However, girls gather in small groups playing theatrical games that don't feature hierarchy or winners. Jones at al. (2000) created competition within the science classroom by limiting access to the materials. As a result, they found that boys were more competitive for access to the science materials. Overall, girls have different preferences for competition, cooperation, and individual instructional settings than boys (Jones at al., 2000; Owens & Barnes, 1982; Owens & Stratton, 1980). Girls have a tendency towards maintaining intimacy, sharing and monitoring each other's emotions while boys have a propensity toward being competitive and hierarchical by negotiating and ranking themselves using insults, direct commands, challenges, and threats.

Some researchers recommend a non-competitive science fair for elementary school students. "The competition factor associated with science fairs is usually reduced at the elementary level to help students feel self-confident and encourage the learning of science" (Bellipanni & Lilly, 1999, p.47). Younger students can receive some kind of reward to reinforce the idea that all students doing a science fair project are winners. Cherniak (1996), investigating the relationship between anxiety toward science and science achievement in elementary students found that anxiety and science achievement are inversely correlated. According to her research, science fairs probably exacerbate anxiety influences because they place a great amount of pressure on students to win in the fair. In addition to the 'anxiety', there is another and very essential aspect of competition: the 'zero sum game', which may prevent sharing and helping among younger students. According to Bellipanni and Lilly (1999), "science fairs can and should be run at all grade levels. The earlier students gain hand-on experience with developing simplescientific concepts, the easier it will be for them to later perform more complex studies in science" (p. 46). On the other hand, Romjue and Clementson (1992) suggest a non-competitive fair for elementary school students because students may realize that in order to succeed others must fail. This realization could even lead to sabotage.

Purpose of the Study

The first student science fair in the USA was held in 1928 and throughout the 1950's, science fairs continued to grow (Bellipanni and Lilly, 1999). Although there are potential problems with judging and concerns around an overemphasis on competition, educators continue to perceive science fair to be beneficial for students (Abernathy & Vineyard, 2001). In spite of the increase in the participation every year in science fairs, very little research has been conducted. Given the increasing amount of time and resources spent on science fairs each year, more research is required. Therefore, this research aims to investigate a series of questions relating the effect of science fairs on students.

1. Do the students who participate in science fairs have a better understanding of the scientific method than the students who do not participate?
2. Do the students who participate in science fairs have more positive attitudes towards science than the students who do not participate?
3. Are there gender differences in understanding of the scientific method between the students who participate and don't participate in science fairs?
4. Are there gender differences in attitudes towards science between the students who participate and don't participate in science fairs?

Method

A pretest/posttest control design was used to study the impact of science fairs. Six teachers from four schools volunteered their time for this research. The sample (N=379 for pretest and N=430 for posttest) consisted of seventh grade students enrolled in regular middle school science classes. During the school year or semester, the experimental group students (N=335 for pretest, N=404 for posttest) prepared their projects for the science fair. The control group (N=24 for pretest, N=26 for posttest) didn't prepare projects and didn't participate in any kind of a science fair. Among the participants, 201 of them were females and 202 of them were males in the pretest and 214 of the participants were female and 242 of them were male in the posttest.

Two instruments were developed for this research. The first assessment, which is called "Scientific Method Questionnaire (SM-Q)", aims to measure if students develop their understanding in scientific method (e.g. can they conduct an experiment properly, define the variables involved in an experiment, and make appropriate conclusions.). The SM-Q is consisted of eight multiple-choice questions with one correct answer. The second one, which is called "Science Attitudes Questionnaire (SA-Q)", aims to measure students' attitudes towards science and science fairs. SA-Q was graded using a four-point scale [strongly agree (4), agree (3), disagree (2), strongly disagree (1)]. The maximum possible score was 104 for 26 questions. At the beginning of the semester all of the participant students were given the pretests. After the end of the school year or semester, both experimental and control groups were posttested. The experimental group had their school science fair before the posttest.

Results

Treatment

One of the independent variables was treatment, which is the science fair. To test for comparability, pretest results were analyzed to determine whether there were significant differences between control and experimental groups in the beginning. The t-tests were analyzed at 0.05 significance level. T-test results showed that the differences between control and experimental groups were not significant (p=0.51 for SM-Q and p=0.48 for SA-Q) for the pretests. Therefore, the posttest results were analyzed. The t-test analysis of SM-Q posttest scores indicated a probability of 0.08, which was not statistically significant at 0.05 significance level. Although experimental group had higher scores in SM-Q, it was not significant. The difference between students who participated at the science fair (experimental group) and who didn't participate at the science fair (control group) was not statistically significant (see Figure 2). The t-test analysis of SA-Q posttest scores (p= 0.35) was not statistically significant, too. The experimental group also had higher scores in SA-Q, however, no statistical difference was found. The analysis indicated that no attitude differences between control and experimental group occurred as a result of treatment (see Figure 3).

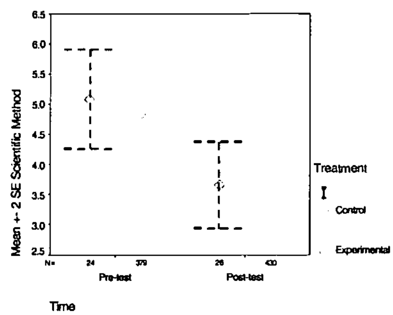

Figure 2

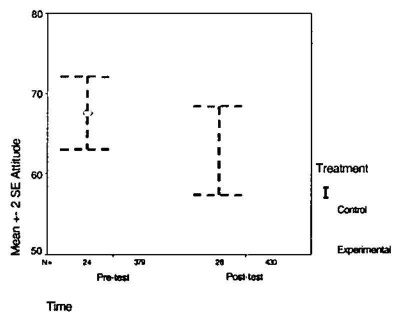

Figure 3

Figure 2. Distribution of control and experimental groups' SM-Q scores for pretest and posttest
Figure 3. Distribution of control and experimental groups' SA-Q scores for pretest and posttest

Gender

T-test results showed that there were significant initial differences between girls and boys in the SM-Q (p=0.00) and SA-Q (p=0.04) in favor of girls. When posttests were analyzed SM-Q scores also showed a significance difference (p=0.00) while SA-Q scores were not significantly different (p=0.89). Girls in both control and experimental groups had higher scores in SM-Q than boys. A drop was discovered in SM-Q scores for both genders in both groups on the posttest. However, as girls' and boys' scores both dropped in parallel with each other, no interaction occurred (see Figure 4). SA-Q scores for the control group showed similar characteristics as SM-Q scores. Scores for both genders dropped, but there were no interactions. The experimental groups' SA-Q scores had different characteristics (see Figure 5). Boys had higher scores in SA-Q than girls before participating in the science fair. After the science fair, girls' scores dropped. Boys' scores also dropped but much more than girls. The experimental boys' and girls' SA-Q scores were almost the same at the posttest.

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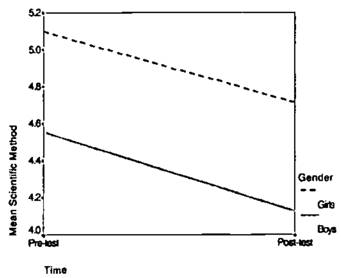

Figure 4

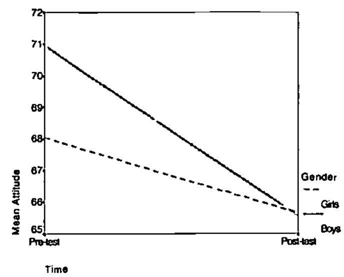

Figure 5

Figure 4. The gender interaction for experimental group' SM-Q scores
Figure 5. The gender interaction for experimental group' SA-Q scores

Discussion

When undestanding of the scientific method scores were compared, the students who participated at the science fair had higher scores. However, this difference was not statistically significant. When attitudes are tested, again the experimental group students showed higher scores. This was not significant either. Gender differences were mostly in favor of girls. Scientific method aptitude scores of girls were higher for the pretest and posttest for both the control and experimental group. Science attitudes scores for the control group also showed that girls did better in both the pretest and posttest. The difference in favor of boys appeared in the experimental group pretest scores. This difference wasn't maintained after the science fair, as posttest results were almost equal for gender. The gender differences were interesting as most research indicates that girls usually have less positive attitudes and lower achievement in science.

This research shows that participating in a science fair didn't cause a significant effect on students' understanding of scientific method and attitudes towards science. These findings indicate the need to be more cautious about practices that have been accepted for years. Science fairs have a long history and are as popular today as ever. Yet, there is not much research to show their impact on students. Despite the continued resources expended on science fairs, there is little research to confirm that science fairs are the most effective, efficient, or equitable way to promote a scientifically literate society. Science fairs tend to select students who already show interest and success in science. Science fairs challenge these students to do their best, however students who need more encouragement to develop positive attitudes toward science seem to be left behind with a "non-winner" ribbon. As educators, if we want our students to enjoy science and to develop a scientifically literate society, we should create environments and activities that encourage all students.

This research had some limitations. Unexpectedly, the scores in posttest were lower than pretest for the control group, experimental group, females, and males. Further research should focus on the reasons that caused this drop. Testing instruments, which were developed for this research, should be evaluated. Testing timing and the amount of science courses that participants take should be considered. In this study, each group spent different amounts of time on science and correspondingly on science fairs.

In conclusion, more research especially on classroom level science fairs, which apply to most students in all levels, is needed. Research on science fairs should address the limitations with a closer look to science fair participants, their teachers, the way they prepare for the science fair, and judging procedures. The outcomes of this 74 year-old activity are still inconclusive.

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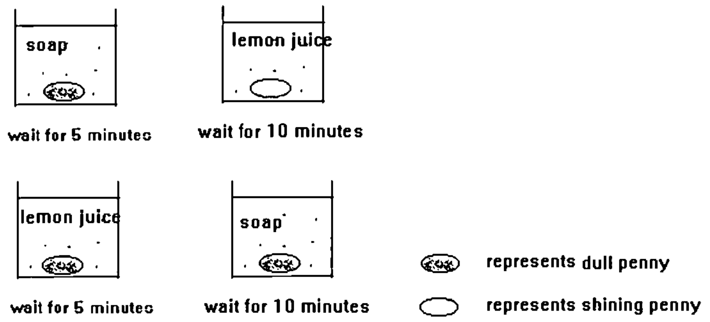
Appendix

Sample SM-Q Questions:

Answer the 1st and 2nd questions according to the following paragraph.

Mary thinks that soap can make metals shiny. However, Nick thinks that lemon juice can polish metals. To find the right answer they conduct the experiment below; They put soapy water in two cups and lemon juice in 2 other cups. Pennies in three cups stay the same while the other becomes shinier.



Drawing a conclusion from an identified experiment.	1) According to the experiment above if you wanted to polish a metal necklace, what would you do? a. Use lemon juice and wait for 5 minutes. b. Use soapy water and wait for 5 minutes. c. Use lemon juice and wait for 10 minutes. d. Use soapy water and wait for 10 minutes.
Stating the variables from a given investigation	2) What are the variables in this metal polishing experiment? a. Type of liquid and type of the coin b. Waiting time and size of the container c. Waiting time and type of the coin d. Type of liquid, waiting time, and brightness of the coin

Sample SA-Q Questions:

	Strongly Agree	Agree	Disagree	Strongly Disagree
I like science.				
I participate in extracurricular science activities.				
I would like to take more courses in science.				
I don't like science because my everyday life requires very little science.				
I would like to participate in science activities such as science fairs and science clubs.				
Only smart students can do science fair projects.				
If I have an opportunity to participate in a science fair, I would love to participate.				

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