

# Teacher Opinions Concerning Science Projects and Science Fairs<sup>1</sup>

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**ABSTRACT.** A 20-question Likert scale and a brief questionnaire concerning science projects and science fairs were sent to approximately 600 randomly-selected high school science department chairpersons in Ohio. Slightly over 30% of the sample returned the survey. Respondents preferred having students do projects as individuals, although working in pairs was nearly as acceptable. Respondents strongly supported pre-service training in structuring independent science research projects for students. A large majority of respondents felt that doing science research projects taught lessons that could not be duplicated by classroom instruction. A slight majority agreed that science projects are valuable, but that judging them in a science fair setting is counterproductive. At the same time, respondents said science fairs promote enthusiasm about science, give students experience in communication skills, and give students the opportunity to interact with other students interested in science. Respondents also indicated that science fairs were more appropriate at the junior high level than at the high school level, although a majority indicated that independent research projects are a more appropriate activity for high school students.

OHIO J. SCI. 95 (4): 274-277, 1995

## INTRODUCTION

Science teaching has changed dramatically since science fairs were initiated in the 1940s. Although science fairs now have a stronger emphasis on experiments, little else about them has changed. Are science projects and fairs an anachronism or has a constructivist approach to science education provided new support for such activities? Should secondary teachers include science projects as a part of their courses or is time better spent on other instructional activities?

Although individual or small group laboratory activities probably cannot achieve all the goals of science instruction (Hofstein and Lunetta 1982), small group laboratory experiences have been found to be a crucial element in high levels of achievement in subjects such as physics (Harpole and Gifford 1985). This article examines the opinions of science teacher leaders to gain an understanding of current practice regarding science projects and science fairs.

## MATERIALS AND METHODS

In an effort to gauge the opinions of secondary school teachers concerning science projects and science fairs, a survey consisting of a questionnaire and Likert survey was sent to 600 randomly-selected science department chairpersons in Ohio. The survey was designed with input from teachers, teacher trainers, and members of the Junior Academy Council of the Ohio Academy of Science. The survey defined an "independent science research project" as a project involving background research, a student-designed experiment, and a report on the results of that experiment; the project may be done individually or in a small group; there is some adult consultation from a teacher or mentor. A "science fair" was defined as an activity where the results of many such projects are displayed and discussed with adult judges. The

accompanying letter urged teachers to reply regardless of whether they had feelings for or against science projects and fairs.

The department chairs were asked to indicate their agreement or disagreement with 20 items in a Likert attitudinal survey (Table 1). The questionnaire surveyed teachers' experiences with science projects and fairs, and the most beneficial ways to group students (Fig. 1). High school department chairs were also asked to indicate the appropriateness of science projects and science fairs at each grade level, kindergarten through twelfth grade.

## RESULTS

Slightly over 30% of the teachers responded. The surveys were returned in roughly equal numbers from teachers in rural, suburban, urban, and small city school districts. The majority of the surveys returned (84%) were from public schools. Slightly over half the teachers (55%) had done a science project themselves as a secondary school student. Seventy-five percent of the respondents encouraged their students do science projects at some point in their teaching careers, and 59% had students who exhibited their project at a district or state science fair.

Department chairs indicated that an individual project was the most popular grouping, followed by pairs, then 3-4 students. Few teachers thought 5 or more students was an appropriate group size (Fig. 1).

Teachers strongly supported preservice training for teachers at all grade levels in how to structure independent research projects for students (Table 1). Fewer than 20% felt that the lessons learned from doing an independent science research project could be duplicated by good classroom instruction, and over 80% felt that projects teach students about scientific methods.

Opinions were more divided when the topic changed to science fairs. Slightly more people agreed than disagreed that science projects were valuable, but judging them in a science fair setting was thought to be counterproductive. On the other hand, fewer than 20%

<sup>1</sup>Manuscript received 27 January 1995 and in revised form 26 May 1995 (#95-02).

TABLE 1

*Science projects and science fair Likert survey results shown in percents.\**

|   | Strongly<br>Agree | Moderately<br>Agree | Neutral<br>No Opinion | Moderately<br>Disagree | Strongly<br>Disagree |
|---|-------------------|---------------------|-----------------------|------------------------|----------------------|
| 1. Secondary science education majors should be given preservice training in how to structure independent research projects for secondary science students. | 61                | 29                  | 9                     | 1                      | 1                    |
| 2. Middle school science education majors should be given preservice training in how to structure independent research projects for middle school students. | 50                | 35                  | 13                    | 2                      | 1                    |
| 3. Science fairs are an anachronism which have no value in the science programs of modern schools.  | 8                 | 17                  | 12                    | 26                     | 37                   |
| 4. Large cash and scholarship awards detract from the real purposes of science fairs.   | 15                | 22                  | 20                    | 24                     | 18                   |
| 5. Science fairs promote interest and enthusiasm about science.   | 24                | 37                  | 16                    | 18                     | 6                    |
| 6. Independent science research projects do little, if anything, to teach students about scientific methods.  | 1                 | 7                   | 10                    | 31                     | 51                   |
| 7. Elementary education majors do not need preservice instruction on how to structure independent research projects for their students.                     | 5                 | 13                  | 13                    | 29                     | 41                   |
| 8. Science fairs provide an opportunity for students to learn about the research of their fellow students.  | 25                | 47                  | 13                    | 11                     | 3                    |
| 9. Independent science research projects are valuable, but judging them in a science fair setting is counterproductive.                                     | 15                | 30                  | 16                    | 24                     | 14                   |
| 10. The opportunity to explain one's research to an outside observer (judge) enhances a student's interest in the research he/she has done.                 | 35                | 39                  | 13                    | 11                     | 1                    |
| 11. Independent science research projects are equally valuable for students of any grade level.   | 13                | 33                  | 10                    | 31                     | 13                   |
| 12. Science fairs give students valuable experience in communication skills.  | 34                | 47                  | 11                    | 6                      | 3                    |
| 13. Science fairs put too much pressure on students.  | 9                 | 26                  | 23                    | 30                     | 13                   |
| 14. The quality of judging at science fairs is generally good.  | 6                 | 46                  | 20                    | 20                     | 8                    |
| 15. Science fairs are a logical evaluation tool for outcome-based education.  | 9                 | 30                  | 27                    | 15                     | 19                   |
| 16. Independent science research projects are not valuable without a scientist mentor to guide the individual or group.                                     | 10                | 29                  | 12                    | 39                     | 10                   |
| 17. Science fairs give interested students an opportunity to interact with other students who are interested in science.                                    | 33                | 49                  | 11                    | 6                      | 2                    |
| 18. Independent science research projects are not compatible with constructivist views of science education.  | 2                 | 6                   | 50                    | 28                     | 14                   |
| 19. Science fair judges should be trained or certified.   | 15                | 43                  | 18                    | 19                     | 5                    |
| 20. The lessons taught by independent science research projects can be taught more effectively by good classroom instruction.                               | 6                 | 13                  | 18                    | 42                     | 22                   |

\*Because of rounding, percentages for each question may not total to exactly 100%.

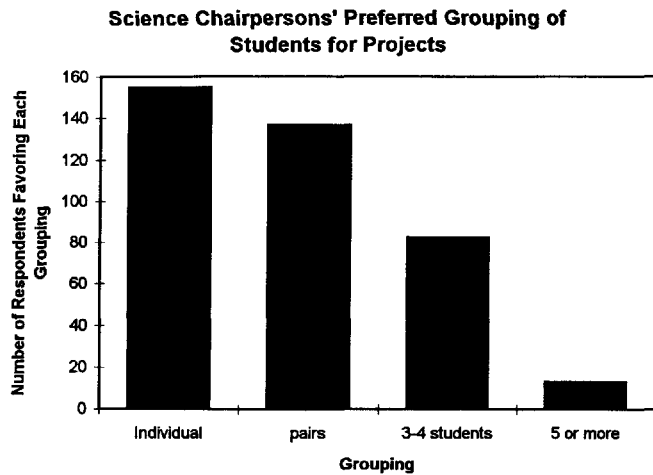


FIGURE 1. Number of respondents indicating each method of grouping as acceptable for an independent research project. *N* = 191.

of the respondents were willing to say that fairs had no value in modern school programs. Teachers, by a substantial margin, felt that fairs stimulate interest and enthusiasm about science, provide students with an opportunity to learn about the research of other students, provide an opportunity to interact with other students who are interested in science, and give students valuable experience with communication skills. Teachers felt that judges should be trained or certified, but most thought the quality of judging at science fairs was generally good.

Teachers indicated that the benefit of independent research projects increases with grade level, but that science fairs are most appropriate at the junior high level (Fig. 2).

### DISCUSSION

A survey similar to that in the present report was done of science education professors (Grote 1995). The results of that survey were strikingly similar to those provided by secondary department chairs with the distribution of most responses correlating at better than 0.9. One rather

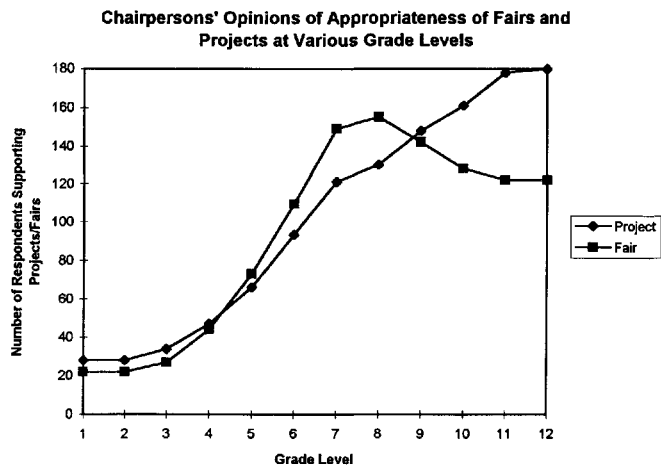


FIGURE 2. Appropriateness of science projects and fairs at each grade level as perceived by high school department chairpersons.

interesting difference is that 50% of the teacher respondents had no opinion about whether independent science research projects were compatible with constructivist views of science education. Nearly three-quarters of the science education professors felt that projects were compatible with constructivism. Many of the characteristics of constructivist classrooms are a part of student research projects, including: placing a high value on the pursuit of student questions, reliance on primary sources of data and manipulative materials, viewing students as thinkers, teachers acting as mediators of the environment, basing assessment on exhibits, portfolios, or observations (Brooks and Brooks 1993). The difference in the results could indicate that many science teachers are not sure about the meaning of constructivism.

Another difference of opinion between professors and teachers concerned cash and scholarship awards at science fairs. While professors believed that such awards detracted from the real purposes of science fairs by a two-to-one margin, teachers, by a slight margin, did not see a problem with such awards. A similar question concerning sponsored awards was asked of students who exhibited at the State Science Day in Ohio in 1994. Students indicated by a two-to-one margin that the awards were a major factor in motivating them to do a science project. This could indicate that many students do projects for potential awards supporting the education professors' opinion. Material awards have been found to positively influence test results (Tainman et al. 1972). Perhaps the incentive provided by the prizes is the driving force behind some excellent student work, explaining the fact that teachers see less of a problem with the awards. Although the university professors have some justification for fearing a negative effect on intrinsic motivation because of awards (Deci 1971), connecting awards to specific goals can increase both achievement and intrinsic motivation (Schunk 1984).

Teachers were more likely than college professors to believe that the quality of judging at science fairs is good. However, large majorities of both teachers and education professors felt that science fair judges should be trained or certified. A poor quality of judging can unnecessarily discourage talented students from pursuing a scientific career. Interestingly, students at the State Science Day in Ohio rejected the idea of training or certifying judges by a two-to-one margin. The students reasoned that communication was an important part of the judging process. A good presenter, they argued, should be able to convince anyone of the quality of a good project. The educators' opinion was influenced by fairness and establishing standards rather than any conflict with the students' reasoning.

Nearly 40% of the teachers (and 35% of the professors) believed that a scientist mentor is necessary to make science projects valuable. Thus, a sizable proportion of the population believes that teachers cannot effectively provide the research guidance necessary for a good science project. Possible explanations include the large time commitment necessary for many such projects or the lack of expertise in a specialized area. If this large minority is correct, however, the number of scientist mentors that

would be needed would be substantial. Student success at the Mississippi State Science Fair correlates highly with the student's access to college or university facilities, but negatively with consultation with a science teacher (Gifford and Wiygul 1992), which supports the opinion expressed by many respondents on the current survey.

Teachers felt that science projects are most appropriate at the high school level, but science fairs are most appropriate at the junior high level. This contrasts with education professors who felt that both projects and fairs are most appropriate at the high school level. The teachers' opinion is closer to reality if student participation by grade level at district and state science fairs is a valid indicator. Fourteen year olds (eighth graders) from low socio-economic levels have demonstrated the ability to design and perform experiments after having instruction even though they had not reached a formal stage of reasoning according to Piaget's model (Case and Fry 1973). On the other hand, a month-long mini-course concerning science research including a session for parents was not successful in teaching fifth graders to successfully conduct independent research projects, and a review of the literature indicated that fifth graders may not have the process skills to successfully complete an independent research project (Daab 1988). Because junior high students show better science performance in cooperative groups (Humphreys et al. 1982), group projects may be preferable to individual projects at lower grade levels, but high school students are capable of completing independent research projects.

Although teachers generally see value in having students display the results of their research at science fairs, a significant portion indicated some reservations. A slight majority of both teachers and education professors claimed that the judging of projects is counterproductive to the purpose of doing a research project. There may be value in exploring alternative science fair structures which de-emphasize awards and ratings. Presenting one's research to a professional scientist (no longer called "judge") and receiving some type of recognition (a certificate or pin?) is a possible alternative. Science fairs operating in such a manner would be similar to poster sessions which are held at professional meetings. The National Science Teachers Association position statement on science fairs (1968) included the recommendation that "emphasis should be placed on the learning experience rather than on competition." Based on student feedback about the motivation of awards and scholarships, however, such a move could reduce

the numbers of students who do independent research projects. On the other hand, it is possible that the reason many students do not currently participate is the competition factor. This question cannot be resolved by the current study.

This study has obvious limits. Only the opinions of respondents are known and 70% of those receiving the survey did not respond. Although the data on the opinions of science education professors was drawn from a national sample, student and teacher opinions were limited to respondents from Ohio. It should be noted, however, that when an initial science education professor sample was expanded from an Ohio-only sample to a national sample, there was no significant difference in the results.

Future studies might attempt to evaluate the validity of the opinions expressed by teachers in this study. For example, a test to determine understanding of valid scientific methods might be designed and administered to students who did science projects and students who did not to determine if there is any statistical difference between the groups attributable to having completed a science research project.

ACKNOWLEDGEMENTS. Funding for this research was provided by a Thomas E. Wenzlau grant through Ohio Wesleyan University.

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