

# Experimental Design Ability Test and Survey Report

James A. Garfield 2010-2011

## Introduction

The Gelfand Science and Engineering Fair Program has two primary objectives: (1) To broaden participation in the science fair experience in schools throughout northeast Ohio with special emphasis on the Cleveland Metropolitan School District and other high need districts in Cuyahoga County, and (2) To promote and support high quality science fair projects that include meaningful questions, sound experimental designs, and rigorous analyses.

The program utilizes several strategies to meet these objectives. These include providing funding for school science fairs, mentoring meetings with science fair teachers, and Gelfand Fellows, CWRU students who assist throughout the entire science fair process.

During the 2010-2011 academic year, we used three tools to measure progress toward our objectives. These include final summary reports submitted by Gelfand awardees, pre- and post-attitude surveys, and pre- and post-experimental design ability tests completed by students. The results for your school and the program as a whole are presented here.

## Methods for Analyzing Experimental Design Ability Tests

Students completed the Experimental Design Ability Test (EDAT) prior to beginning work on science fair projects (pre) and following their science fair (post). Both the pre and post tests were composed of the following problem:

*Advertisements for an herbal product, ginseng, claim that it promotes endurance. To determine whether or not the claim is true and prior to accepting this claim, what type of evidence would you like to see? Provide details of an investigative design.*

EDATs were coded to ensure student anonymity and scored independently by two reviewers to relieve bias in scoring. All non-matching scores were then discussed to generate a consensus score. The rubric was aligned with the Ohio Depart-

ment of Education's Academic Content Standards for K-12 Science and the maximum score was set at 6.

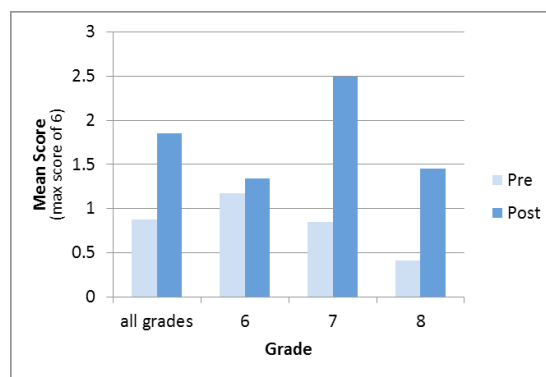
Pre and post scores were analyzed using the following statistics: mean score, frequency distribution of all scores, and normalized learning gain. Normalized learning gains on the EDAT were calculated using the following equation:

$$\frac{(\text{post} - \text{pre})}{(\text{max} - \text{pre})} \times 100\%$$

with post being the mean post score and pre being the mean pre score. Positive learning gains (greater post than pre scores) have values between 0% and 100% whereas negative learning gains (greater pre than post scores) have values between 0% and -100%.

## James A. Garfield EDAT Data

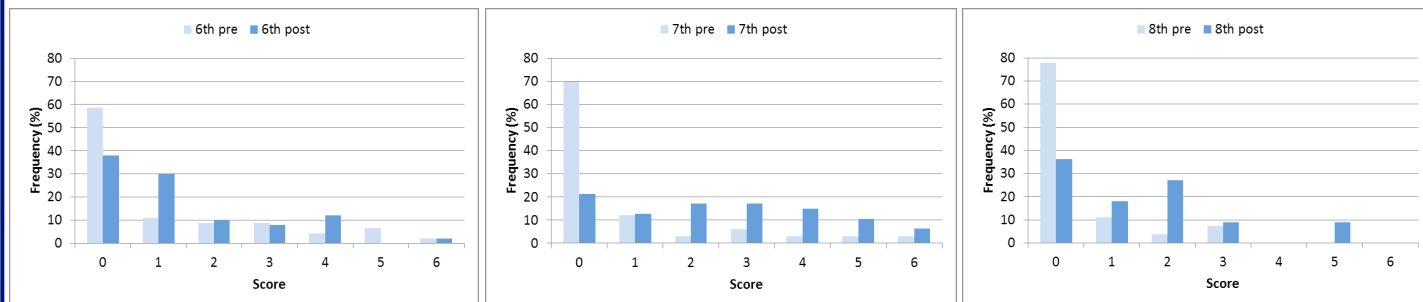
Total # of EDAT tests submitted		
Grade	Pre tests	Post tests
6	46	50
7	33	47
8	27	11



Mean of pre and post scores by grade

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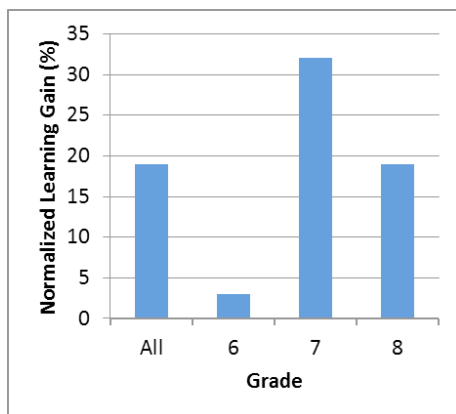
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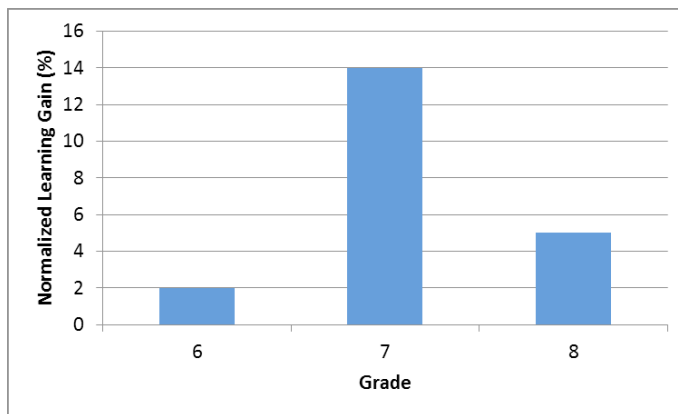
Frequency distribution of pre and post scores

## Comparison EDAT Data

EDAT normalized learning gains were averaged for the data available. The graph on the left show the normalized learning gains for the participating grades in your school. The graph on the right shows the average normalized gain for grades 6-8 of the schools participating in the Gelfand program. Only schools who turned in both pre and post tests were included in the average for each grade. \*Note there is a difference in scale between school and average learning gain.



James A. Garfield Normalized Learning Gain by grade



Average Normalized Learning Gain by Grade

## Conclusions for EDATs

Average learning gains were generally positive, but did not show any consistent trend by grade or school. Limited data and loss of participants from pre to post occludes any conclusion. It is also not possible to know if any additional instruction was given beyond the test prompt.

Teachers indicated that the EDAT was not well understood by many students and could be a contributing factor to the relatively low scores. Scores of zero were included in the analysis; however it was not possible to distinguish between students who could not answer the question and those who chose not to answer the question. However, overall positive learning gains may suggest some increase in ability to design an experiment.

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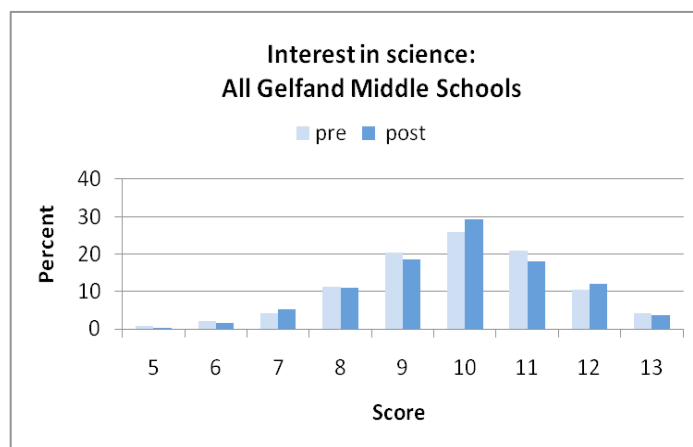
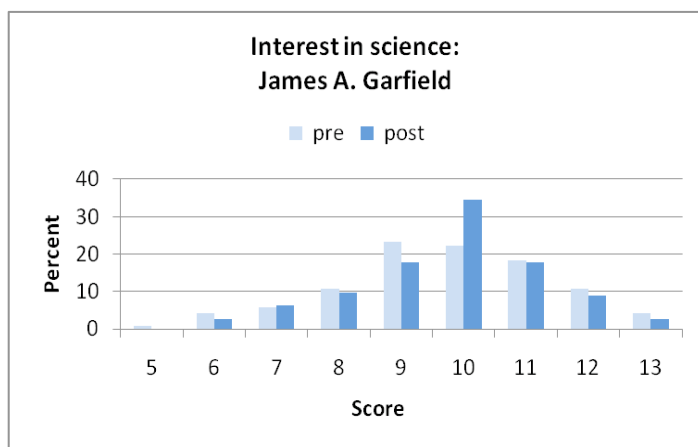
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## Survey of Student Attitudes Towards Science

Surveys assessing students' attitudes towards science were administered both pre and post science fair. The questions on the survey can be broken down into broad categories, three important ones being student self-reported interest in science, student self-reported ability in science, and student beliefs about the importance of science.

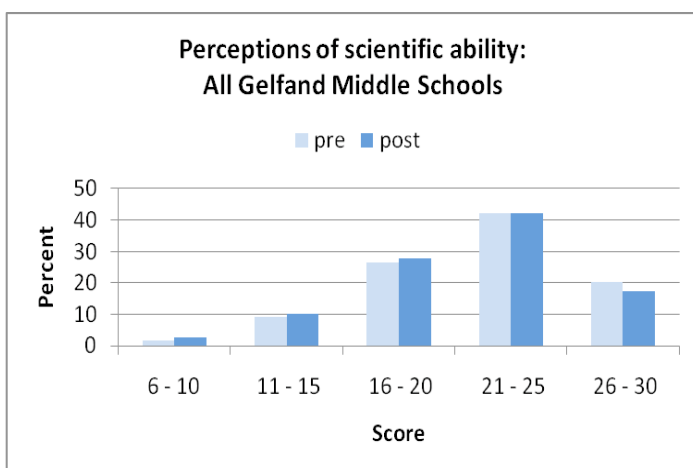
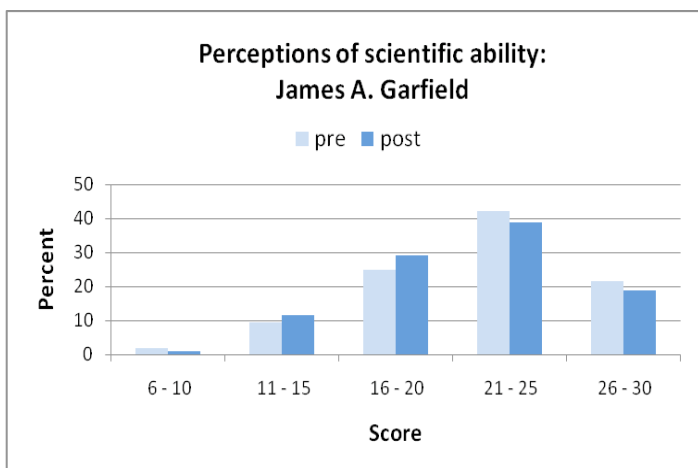
### Student Interest in Science

Student interest in science was composed of 4 items that were answered yes or no, such as "In the past 12 months I have visited a science museum" and 1 item measured on a scale of 1 to 5 assessing effort in science class (1 = don't try at all, 2 = do just enough to get by, 3 = give an average amount of effort, 4 = pretty hard, but not as hard as I could, 5 = work as hard as I can). This gives a minimum score of 5 and a maximum score of 13 in this section.



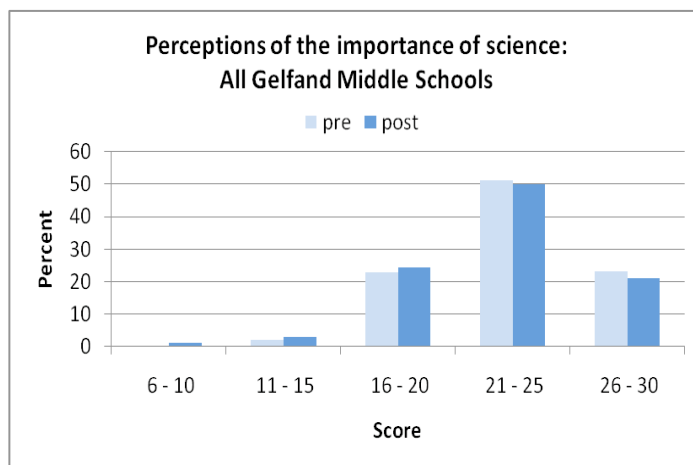
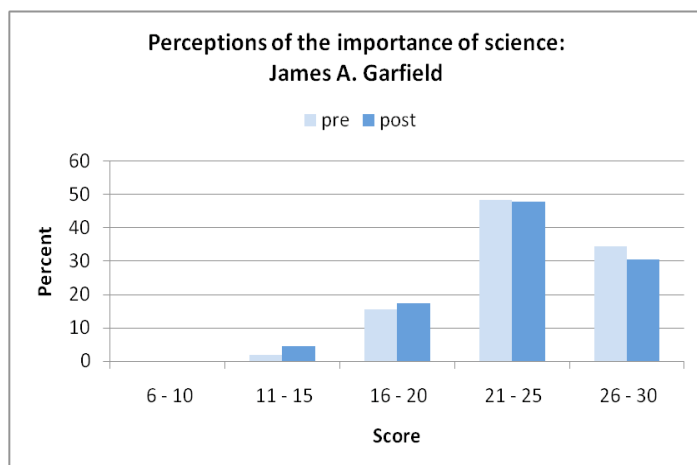
### Student Perceptions about Ability in Science

Student ability in science was made up of 6 questions, which were rated on a scale of 1 to 5, (1 = Strongly disagree, 2 = Disagree, 3 = Not sure, 4 = Agree, 5 = Strongly agree). They included items such as "I enjoy science" and some items such as "Doing science makes me feel nervous or upset" were reverse scored, so that a higher number always represents a more positive outlook on abilities in science. There was a minimum score of 6 and a maximum score of 30 in this section.



## Student Perceptions about the Importance of Science

Student beliefs about the importance of science was made up of 6 questions, which were rated on a scale of 1 to 5, (1 = Strongly disagree, 2 = Disagree, 3 = Not sure, 4 = Agree, 5 = Strongly agree). They included items such as “Science is useful to everyday life” and “Overall, science and mathematics have caused more good than harm in our lives.” One item was reverse scored. There was a minimum score of 6 and a maximum score of 30 in this section.



## Conclusions for Surveys

Analysis of survey trends among all middle school students participating in the Gelfand Science and Engineering Fair program indicated students were generally interested in science, had positive perceptions about their abilities, and recognized the importance of science in their daily lives. The majority of students reported they work “pretty hard” in science and many participate in science-related activities outside of school. More than 60 percent of all 6<sup>th</sup>, 7<sup>th</sup>, and 8<sup>th</sup> grade students in the Gelfand program reported positive perceptions of their abilities in science and less than 10 percent reported negative perceptions. We were encouraged to learn more than 70 percent of Gelfand middle school students reported positive perceptions about the importance of science and less than 5 percent reported negative perceptions.

There were no significant differences in pre and post scores in any of the three survey areas (interest, ability, importance). This is an important outcome because there is strong empirical evidence that science experiences in the middle grades play a critical role in determining future career paths, with unsatisfactory experiences often leading to students pursuing further study in other disciplines. These data would suggest that, to the contrary, students had a very positive experience. Due to the inability to consistently administer the pre and post surveys just before and just after the science fair, it is not possible to determine the direct impact of the science fair process on students’ interests, attitudes, and abilities.

## Contact information

If you have questions or comments about the data analysis please contact James Bader at [gelfandsciencefair@case.edu](mailto:gelfandsciencefair@case.edu) or 216-368-5257.