Examining the Impact of Science Fairs in a Mexican-American Community

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Abstract
This study is a critical examination of the traditional educational practice of participating in science fairs in the elementary and middle schools. The research was conducted in a Texas community near the Mexican border where most of the students’ home language is Spanish, and most of the families are low- to middle-income laborers and working class. High-school students and university seniors majoring in education provided insight via their memories of their participation in science fairs as well as observations of the science fair process at local elementary and middle schools. The evidence suggests that, especially for border students, the science fair experience in the schools is often a detrimental practice that perpetrates traditional reductionist views of science and that involvement in the science fair was preventing many students from enjoying science and achieving science understanding.

Purpose
Science fairs have become institutionalized in schools across the nation, and they are often accepted as an important part of a student’s successful science education. That traditional viewpoint deserves a critical look, especially in communities serving people who are highly under represented in science fields. These under represented groups include minorities, second language learners, and people from low-income communities.

Inequities exist especially in science education for Hispanic students. In Texas, Hispanics represent 42.7 percent of the student population. The dropout rate for Hispanic students has consistently been four times greater than for White students (Texans for Fair Funding, 2004). According to the 2000 National Assessment of Education Progress (National Center for Educational Statistics, 2001), most Texas students are not considered proficient in science. Forty-seven percent of Texas eighth graders were below the basic level in science achievement, and only 24 percent considered proficient or above. This lack of proficiency is even stronger for Hispanic students. The average score across the nation for Hispanic students was 122 out of 300, and, for White students, the average was 162 out of 300. On the Texas State Science and Engineering Fair (TSSEF) web page
the 2003 TSSEF senior winners are listed. Of the 96 winners, only six had Spanish last names. Spanish last names do not always identify Hispanic students. However, it is a strong indication only a small percent of the winners are Hispanic.

Science fairs are applauded universally, but upon closer inspection, for many students, science fairs can be a detrimental educational practice that perpetuates the inequalities mentioned above. We posit that science fairs have become, in many cases, elitist and lead to negative experiences that prevent many students from enjoying science and achieving science understanding. This competitive process is based in the reductionist position where science knowledge is fragmented into parts like chemistry, biology or physics and isolated from the context. The scientific method fundamental to science fair projects is also reductionist in that the scientist is seen as objective, removed from the study, and involved in a mechanical manipulation of phenomena.

Through the research described below, as well as our lived experiences as science educators in border communities, we found evidence of several factors that support the proposition that involvement in the science fair was preventing many students in our community from enjoying science and achieving science understanding. This evidence is examined in four themes. 1) The inadequate support provided to the students who are forced to participate in science fair engenders stress that leads to mental downshifting, and the student responds by fleeing the source of the stress and avoiding science. 2) The science fair process perpetuates a science pedagogy that is not aligned with what we know about how children learn. 3) The science fair process encourages a surface look at science that breeds misconceptions and marginalizes many as they persist with these misconceptions. 4) The scientific method and the competitive aspect inherent in the science fair project constrict science thought to exclude feminist and culturally relevant science and, thereby perpetrate an elite scientific community. These four themes and the evidence we found that support them are described below.

Setting

This study took place in a school district in a rapidly growing urban community in Texas near the U.S.-Mexican border. The population is 90.1 percent Hispanic, 1.28 percent African-American, 0.14 percent Native-American, and 8.14 percent White (Texas Education Agency website). Sixty-eight percent of the students come from low-income families. Thirty-seven percent receive bilingual education services. The community is a jigsaw of urban sprawl, many Mexican immigrant families, unincorporated communities of low-income families living in homes with no interior plumbing on unpaved roads, and a golf club community of retirees.

In our community most elementary schools required that every student submit a project. The district in this study had a district policy that every elementary and middle school participates in an annual science fair by holding a competition. The winners represent the school in a district science fair. In most cases, the elementary principals interpreted this district requirement as a mandate that every elementary student submit a science fair project.
The International Science and Engineering Fair is an annual competition for students in grades 9–12. Detailed guidelines for participation are provided for this competition. Schools and districts adapt these regulations to create smaller scale science fairs. These local fairs often include all grade levels. Some teachers and schools see science fair participation as an option and others make it a requirement for all students. Sometimes, the goal is to select a winner to compete on a state or national level. Other times, the competition stays local.

Although the regulations may vary in the smaller competitions, the basic steps for a science fair project are the same. Students select a topic, research to gather background information on the topic, design and conduct an experiment, present the results of this experiment on a display board, and provide a written and oral report to accompany the project. In the step for designing and conducting an experiment, students are usually required to follow the “scientific method.” This includes the steps of: stating a hypothesis or asking a question; selecting a variable to test; controlling other variables; running the experiment; gathering or measuring the data; recording the data; presenting the data; and drawing conclusions.

Research Methodology

We approached the study from the perspective of critical pedagogy where educational practices are examined critically for their impact on structures in society (Freire, 1996). Many traditional beliefs, often evident in our schools, embed science education in the social reproduction purpose of schools. In this belief, schools serve the interests of the dominant classes by reproducing the economic and social relations of the dominant society (Bowles & Gintis, 1970). In this context, science education, and its accompanying technologies, are reduced to a narrow set of skills and abilities—those that serve the market economies. The social structure that keeps many of our border citizens in minimal wage positions is reproduced.

We have over fifty years of combined experience as science educators in schools in the southern United States near the Mexican border. Our lived experiences watching the science fairs over many years and observing their effects on our students developed in us this need for a deeper examination of science fairs and formulated the basis of this investigation.

We examined the impact of the science fair experience via a phenomenological design to understand the experience from the participants’ point of view. We derived the meanings about this phenomenon via our own experiences and the perception of high school students and university students in this community. The participants were 119 high school juniors and 125 university senior elementary education majors. Ninety-five percent of the total participants were Mexican or Mexican-American, and seventy percent were women. The university education majors provided additional secondary information via their observations of the science fair experiences and interviews with science fair participants in their internship schools.

The university education majors interviewed the students in their internship schools who were involved in the science fairs and provided summaries of these interviews. In
addition, they were asked to write comments about their own science fair experiences. The high school students responded to a written survey (Appendix 1) asking them to provide short comments about their participation in the science fair.

### Table 1

<table>
<thead>
<tr>
<th>Participants</th>
<th>Instrument</th>
<th>Qualifying information</th>
</tr>
</thead>
<tbody>
<tr>
<td>119 high school juniors</td>
<td>Survey with short comments</td>
<td>22 had never participated</td>
</tr>
<tr>
<td></td>
<td>Telephone interviews</td>
<td>20 telephone interviews</td>
</tr>
<tr>
<td>125 university senior Education majors</td>
<td>Reflections on personal experiences</td>
<td>30 had not participated,</td>
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<tr>
<td></td>
<td></td>
<td>40 positive replies,</td>
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<tr>
<td></td>
<td></td>
<td>55 negative replies</td>
</tr>
<tr>
<td>125 university senior Education majors</td>
<td>Comments about observing the science fair</td>
<td>20 positive experiences from “winners,” 43 negative or exclusionary experiences</td>
</tr>
</tbody>
</table>

### Results

The results of the analysis of this data show that, overall, the view of science fair is not memorable, and those experiences that were remembered were slightly more negative than positive. Approximately one fourth of the university students who did participate in a science fair did not remember anything about the experience. Only 40 reported it as a positive experience, and approximately one half reported it as a negative experience. Most high school students said they did not remember much about the science fair experience. When asked to think about a positive science fair experience, only 23 percent could relate a positive experience and then several of them commented that the good experience had bad effects. When asked to think about a “not so good” experience, about 30 percent remembered one and commented on it. The children in the internship schools provided positive interviews when they had been successful participants in the science fairs, although the ability to elaborate on the science content in the project was minimal. The majority of the children involved in the science fair experience provided little or no comment or gave vague and confused information about what they were learning in science via the science fair experience.

### Inadequate Support

The importance of outside help in making the science fair a positive experience became very evident. Many of the high-school students who gave a positive account of the science fair also credited their parents and, less often, friends and teachers for helping them succeed. In one elementary school, the principal understood the need for family involvement and was very concerned that projects be family and community focused. She required that the projects at her school include that component, and did not require a scientific experiment for all the projects. One of the family-focused projects in this school
was from fourth grader, Joe. Joe was very concerned that his dog could get out of the gate to his yard, but could not get back in. He and his father worked together to design a gate that the dog could manipulate both directions.

One of the high-school students, Sylvia, also had a positive project with family and school help. Her comment below about her confidence and positive attitude via the science fair experience credits her outside support.

My parents always supported me and the protein project was a group project so I had the support of my friend. My teachers helped me by suggesting some ideas for the projects that I eventually chose. When I presented in class I was critiqued so that I was prepared when I presented in the real science fair in front of the judges. Though it was complicated, it made me learn.

We agree that it is a very valuable experience for students such as Joe and Sylvia. However, in most cases, it is this outside support that presents an “unlevel playing field” for students in our community whose parents are working class parents with limited time and financial resources for all of the children’s extra needs. In addition, many families in our communities do not have the academic wealth of successful science fair experiences, or successful in-school science education, to pass along to their children.

Comments from students who were left without sufficient support were more common. It became evident that the students were placed in a stressful situation that they associated with learning science. They downshifted mentally (Caine and Caine, 1994) and revert to the basic human instinct of flight. They fled away from science.

One student reported that he liked science but, “after that last experience, I don’t think I’ll do science fair again.” He did everything by himself. Another girl reported that it was boring, and she is not into science. She had only the help of a bigger sister that she credited with helping her understand the “harder books.” Her description indicates that the home resources were limited, and she was left to enter the competition for school resources. “At school there was a teacher’s computer and sometimes we could use that, one at a time. We could stay after school if we wanted to ask more about our experiment.” When Sam was asked about how science fair affected his feelings about science in general, he responded, “Well, I kinda like it still, but not that much anymore.” He said his experiences were bad and he did not have any support. “Me and my group did it by ourselves.”

An English language learner, Alejandro, offered an elaboration. “I tried to do the experiment that I found in a book in the library, but I needed help because it was written in English. The teacher helped me read it and understand it. When I got home and tried to do the experiment, I got confused again. I could not ask my parents because they do not read English, and I felt too embarrassed to ask the teacher to help again. So, I just didn’t do it.”

Another English learning student, Jackie had more success, but the extra effort she had to spend cast a negative feel to the experience. Although she had a successful learning experience, the competitive aspect of the formal presentation and judging left a distaste for science – she too fled.

“At first I did not want to participate, but because it was going to affect my science grade, I participated. I was, like, so mad because …of the judging.
I don’t speak that much English and what if I got a judge that spoke only English. What would I do? But the teacher said I could request a Spanish-speaking judge, I felt so much better. The hardest part was finding an experiment. I changed experiments, like, twenty times. When I found one I liked, I had to research it. I hated that part…too much reading and some things I did not understand. But once I was done, I learned a lot about my experiment on optical illusions. I did not care too much for the science fair itself because, even though I had a Spanish-speaking judge, I was still very nervous. I do not like feeling nervous.”

Families Placed in Compromising Position

We also asked the high school students to respond anonymously to questions about the extent of “help” that was given to science fair projects. In response to the question, “Did you ever do a science fair project where someone else did almost all or all of the project?” The reply was “Yes” for 33 percent of the 117 students. When asked, “Do you know anyone who did a science fair project where someone else did almost all or all of the project?” 68 percent said, “Yes.” The students volunteered comments such as,

“Some students get lots of help. You should see how nice those experiments are.”
“I don’t think those should be judged the same as the ones who did it themselves.”
“Actually, the experiments that the parents make are the ones that win, I think, cause they come out better.”
“I think sometimes the parents do help a lot. I think this happens because the kids need a lot of help doing it.”

The university students involved in the schools also provided evidence of several projects that were done entirely or almost entirely by someone other than the student who claimed the project. This unethical practice in elementary science fair has become very common. It deserves more investigation and attention.

One factor that feeds this practice is the mismatch between the student’s ability level and the requirements for a science fair competition. Because the science fair experience was too difficult for the children, it engendered dependence on outside help, even to the level of outright cheating. The students did not have the knowledge or ability to do the science fair experience individually, and rarely did the teacher provide the level of support that the students needed. The student was placed on a track for failure. The families intervened. Those family members who were well prepared with a science background provided the learning experience that the school did not provide. The families who were less prepared, provided whatever was needed to help their children succeed in the competitive experience. The families were themselves placed in a compromising situation. They were forced to choose between allowing their children to fail or providing assistance in an unacceptable manner.

How Children Learn vs. Science Fair
The science fair process is not aligned with what we know about how children learn science. The linear, controlled experimental approach to science via the “scientific method” inherent in a science fair project is based in the reductionist view of science that separates and isolates, and narrows science learning to only one small aspect of doing science—the controlled experiment. Via this reductionist view, science knowledge is fragmented into parts like chemistry, biology or physics isolated from its context, and scientists distance themselves from their study by being objective and by controlling their environment. Victor and Kellough (1993) in their book, *Science for the Elementary and Middle School*, describe a linear approach to the scientific method as “lethal to a child’s natural interest in science” (p. 24).

Instead of this linear approach, science should be contextualized; situated in integrated, complex, real-world, and relevant subject matter. The content, rather than extracted to a tri fold display board, is placed in the context of real issues and problems in the student’s world, leading students to make sense and find meaning in their world. Teaching in this manner elicits student inquiries and desires. Purpose and meaning are critical to peak understanding. Rather than “schooling” the child, teachers provide a meaningful context whereby the child can “learn to learn” and ultimately apply the knowledge to effectively navigate a personal journey through life in a manner that is molded by culture and personal desire rather than a prescribed journey.

Humans are inquisitive by nature and are attracted by new ideas. We always want to know more. We, and especially the youngest of our species, are natural scientists, ready to explore, ask questions, investigate, observe, and wonder about the world around us. Our brains are programmed to explore our natural world in a natural way. Kovalik (1997) defines content that comes from the natural world around us as meaningful content. Students can access this content because it is age-appropriate. It is complex enough that the brain struggles to seek patterns and create meaning. The content is related to the learner’s prior experiences and is useful to the learner.

In the National Science Education Standards (National Research Council, 1996), science is presented as a process of exploration and investigation rather than the linear steps of the traditional scientific method. It emphasizes the kinds of thinking required to do science, and the critical thinking processes required to solve problems. Science is fluid and uncertain, and scientists make decisions knowing all variables cannot be controlled and all answers are not transferable. Science processes are reconceptualized as tools for exploration and making meaning rather than the formulas for finding answers. Science learning is rich exploration where ends emerge from within the process and are not external to it.

The controlled experiment, as it is operationalized in the steps to the scientific method of a traditional science fair experiment, is beyond the developmental and ability level of most elementary children. The National Science Education Standards specifically address the development of the abilities to do inquiry and do not support the step-by-step sequence required in most science fair projects for young children. “…children in grades K-4 have difficulty with experimentation as a process of testing ideas and the logic of using evidence to formulate explanations” (p. 122). Children at this age are encouraged
to ask questions, plan and conduct simple investigations based largely on observations, and use simple tools to gather data. With guidance and experience they begin to develop reasonable explanations and communicate their investigations as well as reviewing and questioning other’s work.

Surface Look that Breeds Misconceptions

We found almost no evidence of children engaged meaningfully in doing science in context, although some considered science fair participation as a positive experience. However, from all our data sources, the majority of the positive comments were generic comments such as, “I learned a lot,” “It was fun,” “Interesting,” and even “Fine and dandy.” A few comments credited increased interest in science, and one student credited it as important in deciding his career path. A very few could relate the actual content, and those did not indicate any depth of understanding. The following were the only comments in all of the data that mentioned content.

“I learned more about why diabetics can only chew some type of gum.”
“I poured water in a plate and sprinkled pepper. I grabbed a soap and put it top of the pepper. It is interesting to see that the pepper moves to the sides.”
“I did an experiment about the protein found in nuts.”
“I did but I only remember some tornado project, that’s all.”

There was minimal evidence of a depth of understanding of science concepts because of science fair participation. We found a few interviews with elementary students where the student could elaborate about her/his project, but in most of the cases the student provided little evidence of understanding a science concept in depth. None of the high school students provided evidence of their science fair experience building strong understanding a science concept.

In most science fairs, there are winning projects that demonstrate a strong understanding of how to do science and an in-depth knowledge of new information. However, in the local competitions, these are rare. Few science fair participants (very minimal in our data) leave with a solid and deeper understanding of science concepts. The shallow content further enforces a belief that science is magical and its understanding is unattainable. The students touch upon a concept and quickly forget it or misunderstand it. This puts them on the road for a private universe of their own misconceptions.

Elitist Science

We found evidence that the tradition of science fairs is killing the student’s initiative, leaving us to question the underlying purpose of this aspect of education. In the science fair design, students like Sylvia and Joe, above, are poised to fill the power positions in society vacated by their parents because they have successful educational experiences rich in resource support and a history of academic wealth from the dominant, Western point of view.

But most science learners in our community are not in this advantaged position. Science fair, and other aspects of school, perpetuates the dominant society’s economic and social relations by encouraging students to self-select out of science learning.
The high school students’ negative comments included these, and we present them grouped together. They demonstrate the death of initiative.

“Lost, bored, sick of. Empty, confused, frustrated, useless. It was boring, dull and a waste of time. Not as fun. I didn’t like it. It took up my Saturday. I remember I came home mad. Boring, dread, time-consuming, tedious, pointless. It was too much work. It was a waist [sic] of time. Broken, unappreciated, cheap, stupid. It was long and boring. The science fair conflicted with a track meet. They did not have anything exciting. They made me write too much reports and junk. It was boring and hardly any point. I never had a good experience. Late nights of working, not for a grade, but is mandatory. I wasn’t really prepared. I couldn’t explain. It took a long time. Last minute thing. Not prepared. No research. Bad, rushing, to fast. Didn’t have time to work. Kids put a lot of effort into it and sometimes get nothing out of it. Didn’t have it done in time. It took a lot of my spare time.”

Instead of encouraging all students to become scientifically literate, the competition in the science fair is designed so that almost all participants are losers in science. First, at the school level, most students do not participate or do not win the school competition. Of those few who do go onto the next level of district competition, most do not win, and take their turn at being losers. Only the small fraction who make it through the various levels of competition feel like winners.

Many students are not competitive by nature. This competitive nature of science fairs, joined with the inadequate support for science fair projects and their mismatch with learning abilities and styles, places many students in extra stressful situations that encourage them to remove themselves from further science learning activities.

The university students’ comments show the impact of the stress. These were all Mexican-American women, and none of them selected science fields as careers.

“I can only remember feeling the pressure of having to make a project and I had little or no support from my parents because they were not strong or even comfortable in science. I just remember trying to get ‘out of it’ as hard as I could—to the point of faking sickness.”

“I didn’t know what I was doing, and I was so embarrassed because my project was not what was expected.”

“I won first place and went on to District Fair and then fell on my face. I loved doing the research but hated the fact that I had to do it.”

“It was a negative experience for me because I did not have the resources to compete against the other students.”

“I always entered the school science fair because my teachers made me do it. I guess I never really enjoyed it because I was forced to do it.”

“I really had no guidance in coming up with my projects. It was not a positive experience.”

“It happened in the fourth grade when I was in an English immersion class. I did not speak good English and had a very hard time understanding what I needed to do. My project was not displayed at the school’s science fair, and
I have not enjoyed science since.”

If we leave science learning up to those who have the cultural capital, the educated elite, we perpetrate a vicious cycle. Only those who are privy to the methods of accessing science can obtain science understanding. Unfortunately, often our perhaps well-intended science educational practices force many students to escape from science at the first opportunity. At best, the marginalized remain on the margins. We eliminate the hope of an educated populace.

What if every student became scientifically literate? What if science was learned in the context relevant to the learner, in a safe and collaborative environment? What if science became a lens for examining power structures in society? What if the women above had the educational experiences to empower them? Perhaps, then, their comments to us would be like the following.

“Our project was a team project and it was ongoing. We learned about brain chemicals and how they affect behavior. We did an in depth study of previous research on how serotonin levels affect children’s self-concept. I’ve used this information to help guide my teaching.”

“A friend and I compared the national budget allocation to different kinds of scientific research -- from defense budgets to cancer research to international women’s health issues. Now we advocate politically for more equitable funding to support women across the globe.”

“My project was to explore the amount of and effect of the synthetic estrogens that are released from plastics that babies and young children encounter. I’ve shared the information with local child care providers so they can avoid using plastics that release high levels of these toxins.”

Opening science to an approach that involves learning in context, in an inclusive, non-competitive atmosphere could reverse the current ratio of few science fair winners and many science fair losers. All students could be science winners and active participants in constructing a scientifically literate society.
References

Texas Education Agency, School District Locator. Available at  http://deleon.tea.state.tx.us/SDL/
NOTE: We acknowledge and appreciate Letecia Medez and the TED5300 graduate students for their assistance with the research. Appendix

**Science Fair Survey**

1. Overall, my feelings about science fairs are:
   1 . . . . . . . . 2 . . . . . . . . 3 . . . . . . . . 4 . . . . . . . . 5 . . . . . . . . 6
   *Positive* 
   *Negative*

2. I participated in a science fair in the elementary grades:
   ___Never  
   ___One time  
   ___More than one time  

3. Did you any awards in your science fair experience? Describe it if you did.

4. Select one good science fair experience you had in elementary school (if any). Think about this experience and answer these questions about this experience honestly.
   ___ This science fair experience made me understand and appreciate science more.
   ___ I don’t remember much about this science fair experience.
   ___ The science fair experience had some bad effects.

5. Write about 5 words about this experience.

6. Select one not so good science fair experience you had in elementary school (if any). Think about this experience and answer these questions about this experience honestly.
   ___ This science fair experience made me understand and appreciate science more.
   ___ I don’t remember much about this science fair experience.
   ___ The science fair experience had some bad effects.

7. Write about 5 words about this experience.

8. May we call you to find out more about this experience? (We will get your parent/guardian’s permission first.)

   Name:__________________________________ Phone:_________________________

   Parent/Guardian’s name:________________________

   Should we talk to your parent/guardian in Spanish or English? ___________________
Anonymous information

Did you ever do a science fair project where someone else did almost all or all of the project? ________

Do you know anyone who did a science fair project where someone else did almost all or all of the project? ________________
TELEPHONE INTERVIEW QUESTIONS

Intro: We are doing a research to learn more about how to make teaching science better. We want to know more about what happens to students involved in the science fairs. I hope you can help us.

1. Describe your past science fair experiences.

2. Tell about the support you had with your science fair project? If the student does not include this information probe deeper asking about teacher support, home support, or support from others at the school.

3. What kind of resources did you have? Computer, equipment, backboard, etc.

4. How did the science fair affect your feelings about science in general?

5. Did your participation in the science fair increase your knowledge of science and the scientific process skills? Please explain.

6. Some people would think a reason students don’t succeed in the science fair is because the parents do most of the work and the students cannot explain the experiment. What do you say about that?

7. How do you think the science fair experience could be made better?