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## Inspiring Students in Careers in Science, Technology, Engineering, and Math (STEM) Using Science Fairs

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**Inspiring Students in Careers in Science,  
Technology, Engineering, and Math (STEM) Using  
Science Fairs**

**Sydney Guire**

**Senior Capstone Fall 2022**

### **Abstract**

Science fairs have many benefits when it comes to students' academic success. They are an opportunity for them to explore, experiment, and find their own interests. Science fairs help provide students with experiences and pursue future careers in STEM. Given the importance in STEM, not all school districts host science fairs for their students. The purpose of this capstone project is to examine the benefits of science fairs on students through the use of literature review, teacher and school administrator interviews, and student surveys. The findings indicate that science fairs inspire students to create a love for science and continue their education beyond the school yard, as well as questioning a career in STEM in their future.

## **Introduction and Background**

Science Fairs are an experience that will inspire a student and become a memory for a lifetime. I remember my science fair as a kid, it was a project based on where mold grew the fastest. My mother and I got 6 pieces of bread wet and placed them in plastic bags around the house. After a couple weeks I noticed the darker and more moisture there was the faster the mold grew. I then created a presentation board of all my findings, and showcased them in a science fair my school hosted. I did all of the presenting on my own, and it made me feel great to teach others based on an experiment I created. “ The Next Generation Science Standards states that students can only learn about scientific inquiry and the nature of science by directly experiencing those practices for themselves.” (Lakin et al, 2021, p.658). I want every student to be able to participate in science fairs, because the more they work in the field of STEM the more they grow a passion for it. The more they practice how to conduct research and create and experiment the easier it will be as they grow up.

Science fairs have been an exciting opportunity for students to branch out into the field of STEM for decades. While being a fun academic experience that a student gets to choose and develop, they provide the opportunity for a student to learn/practice how to create a question/hypothesis, conduct an experiment, create a conclusion, as well as present their findings. “ Science fairs provide students with an opportunity to investigate interesting questions, work independently, and engage in what we think of as authentic science experiences. These experiences are critical for engaging students in STEM and potentially inspiring them to pursue

STEM careers down the road,” (Levy et al, 2019 p. Q3). Therefore science fairs help expand a student's knowledge and create a passion for what they are learning. They allow the individual to critically think, as well as work physically which allows one to begin the curiosity of STEM and continue a passion for a life long learning.

Science, Technology, Engineering, and Math (STEM) jobs are on the rise in the US, but according to the Department of Education only about 16% of high school seniors are interested in being STEM professionals. (US Department of Education 2013). One way to help turn around this percentage is more participation in science fairs. There are many different types of science fairs that schools can put on, and students can participate in. By starting to participate in science fairs at the elementary school level. That will inspire them at a young age and allow them to pursue that inspiration throughout their remaining time in education. Wade Doss, Huntsville Center's Civil Structures Division chief was a judge at a science fair. He witnessed many great opportunities that the students were receiving from participating. “It's important for them to hear from, and get feedback from, engineers and scientists because those are the people who do these things for a living. So, hopefully it will inspire them to be an engineer or a scientist one day.” (Newcomb 2016 p.1). Wade Doss is correct in that, not only are science fairs an amazing opportunity for students to conduct their own research and experiment, it is also a great opportunity for them to meet professionals in the field of STEM.

As a future educator myself, with a minor in biology, I want students to be exposed to the same opportunities as I was to help them find their passion for STEM. As a 21 year old soon to be college graduate I still think about my project in my science fair as a part of why I am minoring in Biology today. It inspired me to continue to do more experiments, and scientifically question more. It helped me believe in myself and made me more confident. I was

able to create a question, conduct an experiment, and then educate others on my findings. I enjoyed my science fair, and even got inspired to get a career where I can teach others about STEM, and hopefully they will have the same inspiration on others.

Given the importance of STEM, my research is based on seeking the answers to the following research questions. My primary research question is: How do Science fairs inspire students to pursue a career in Science, Technology, Engineering, and Math (STEM)? To seek the answer to this research question I will be asking the following secondary or related research questions.

1. What are science fairs, how did they come about, and how many types of science fairs are there?
2. What does research say about the benefits of science fairs on students in pursuing a career in science, particularly in Science, Technology, Engineering and Math (STEM)?
3. What motivates students in getting involved in science fairs?
4. If science fairs benefit students in inspiring them to pursue careers in science, how do school districts put together science fairs
5. Are there resources available for school districts to plan, organize, and implement science fairs in their schools?
6. How are teachers involved in their student's participation in science fairs, and what rewards or future opportunities do they foresee their students receiving from participating?

Science Fairs are a memorable and informational experience to students. My past experiences of participating in a science fair have stuck with me all through my k-12 experience, as well as my college experience. To answer my primary research question, as well as my

secondary research question, I conducted many weeks of literary research and a few interviews for personal experience.

## **Literature Review**

As mentioned above, I conducted weeks of literary research and interviews to answer my primary research question, and secondary research questions. The following section is my results from my research, and answers to my questions.

Science Fairs can date back to 1921 when journalist E.W. Scripps created Science Services as a nonprofit organization in 1921. His intention was to close the gap between scientific achievement and the public's knowledge of such achievement. The first science fair was called The Children's Fair and it was held in 1928 at the American Institute in New York. Its goal was to connect students with nature. From here science fairs began to expand into diverse specific topics such as; physics, engineering, astronomy, and biology. By the end of World War II, science fairs had a new meaning; to prepare the scientists for the future. "Science fairs are an event at which students' mathematics, science, and/or engineering projects are evaluated and celebrated. Students typically carry out projects either within or outside of the context of their schooling and, then, compete at the school level for the right to exhibit summaries of their projects at a regional fair and, if successful, they may then compete for awards at a national fair." (Bencze & Bowen year 2009 p 2463). "The term 'scientific practices' was introduced to provide more guidance and structure to the concept of inquiry. These practices include the skills, reasoning abilities, and content knowledge that are necessary for students to engage in investigations about the natural world" (National Research Center [NRC], 2013).

***Motivations to get involved in science fairs.*** There have been many studies done about what motivates a student to want to participate in their school's science fair. To start in the area

of motivation we have to start with learning styles. Research usually classifies students' learning style based on their social relationship, emotion, and cognitive preference. For instance, Grasha (1996) classifies learning styles into six types: competitive, collaborative, avoidant, participant, and social relationship. Conwell et al (1987) and Melear 1990) found the relationship between students' learning styles with their achievement and reaction toward instruction. Science fairs help a student learn by being competitive and rewarding (achievement) toward the experiment done from the student. The first component to a student's motivation is the interest for science.

This is an obvious motivation because if a student has a love for science they will want to showcase that passion in the science fair. The second is a sense of self-efficacy, which can also be linked with the interests. In academic context, self-efficacy means the way in which students evaluate their own cognitive abilities to perform learning or meet a certain objective related to learning. (Schunk, 1985). The third component is related to the social aspect of participation in science fairs. Just like participation in any school event, young students do it as a means of traveling to a new place, meeting new people, and getting to share their ideas with others. The fourth component is receiving gratification, achievement, or a reward that the student could get for participating in the science fair. We all love hearing good comments, if a student is proud of their project and they receive positive gratification or even a reward, it provides pleasure to the emotional part of your brain, and it makes you feel proud and accomplished. The last motivational factor is the learning strategies that are created from the conduction of the experiment as well as the showcasing of your experiment at the science fair.

The basic key to getting a student to be motivated in participating is their interest in the topic. They don't even have to be interested in the science fair itself, but if a student is interested in their topic/experiment that they will be motivated to participate. As well as self



efficiency. The more positive promotions about the science fair in a classroom the more likely a student will participate. Rewards are also a huge way to get participation. When a student works really hard, and their hard work pays off, the more likely they are to participate in a science fair in the future.

***How science fairs are organized, and the resources available.*** There are many steps and people involved when it comes to planning a science fair. Administrators of the school district are to approve the schedule and planning of a schools science fair. However, anyone can propose the idea of a science fair, including teachers, parents, or even students. Science Buddies is a website that mentions everything you need to know about science fairs. They mention how there are many steps when it comes to planning a science fair. The first one is to set goals for your science fair. It is very important to make the experience positive for each student; every student should come away with a sense of accomplishment. This makes the science fair enjoyable, and will most likely lead to a student returning to participate in following years. You also want students to be able to showcase what they have learned in school, as well as what they have taught themselves throughout the process. The next step is to set the date and place for the science fair, having a schedule is super important. You want to be able to know what materials, such as tables, microphones, etc. You will need, as well as judges, guest speakers, administrators, and parents to be able to come and support the students. Because the goal of a science fair is to have students create a passion for STEM, when organizing a science fair it is important to have judges that have careers in these fields. Hearing positive feedback from professionals that a student will look up to is a memory that will inspire them to pursue that passion. There are many different organizations that provide funding for science fairs. There are also a lot of volunteers that participate in putting on the science fair.

*A teacher's involvement and the rewards and future opportunities students will receive.*

Teachers play a very important role in getting students to participate in science fairs. A lot of teachers will require their students to participate in the science fair, because it is an individual activity emphasizing their science processing skills. They motivate their students because as the motivational theory suggests, at the developmental stage many young students experience a decline in motivation and may need external support/motivation to help them engage in different activities. Some rewards that teachers, as judges, have witnessed is the opportunity for students to use and understand the scientific method as they design and perform their experiment for others. In a science fair students will identify problems, propose solutions, conduct fair tests, analyze data, and draw conclusions. Science fairs also help students build communication skills, learn the nature of science, and potentially prepare for science careers. (Abernathy & Vineyard 2001 p.269).

## **Methods and Procedures**

Since the start of our semester, I knew that I wanted to focus my capstone project on the science field and the elementary school level. After going over a few ideas with Dr. Thao, and completing my research prospectus, I was able to refine my topic and begin my research. To answer my research questions posed in the Introduction and Background section, I gathered and examined many peer-reviewed scholarly research and journal articles that were related to my research topic. There were many times when I was using OneSearch on our school website and there would be nothing to find for the question I was asking. After a few tries, by remaining positive I broke my question down into simpler terms and then was able to get the articles I was looking for. Aside from finding articles and journals, I also spent time conducting my own

research. I spent several hours creating a survey for elementary school students, as well as interview questions for their teacher. I was also able to have a phone interview with a super independent who was able to tell me all about the planning of a schools science fair as well as the resources they had been able to use.

I was able to stay in contact with a fifth grade elementary school teacher whom I had previously worked with. I contacted her in the beginning of September to give the general information I had already acquired from the few weeks we had been in class for our Capstone. I asked if later in the semester I would be able to interview her for some added information and research for my project. I also asked if I would be able to print out a survey for her students to fill out anonymously for my project. She agreed and when I had the information ready we planned when we would meet. Both events took place on the same day, so she could continue with her teaching she was working on previous to my interaction.

My method and procedures in this senior capstone research include literature review, interview with a 5th grade teacher (See Appendix B for Teacher Interview Questions), and design a student survey (See Appendix A for Student Survey), and another interview with the school superintendent.

The interview (See appendix B) was an in-person interview to which I set up several questions beforehand that I wanted to ask my teacher. The goal of this interview was to help answer one of my secondary questions; How are teachers involved in their student's participation, and what rewards or future opportunities do they foresee their students receiving from participating? There were several questions that range from how many science fairs she had been involved in, to what benefits she witnessed her students receive from participating. There were times when we dove very deep into a question that sparked an entire conversation, other

times it was a simple question that only required a simple answer. My hopes for this interview was that at the end I would be able to pair my interview with the research I had previously done and match most of my information. After the interview I can confidently say that I was able to triangulate the data for the results and findings to respond to my research questions.

The Student Survey (See Appendix A for Student Survey Form). I designed an anonymous survey that was printed and handed out by my teacher to the student in her class. Creating the questions for this survey were a little difficult because I wanted to make sure I was able to include those who have participated in science fairs, and those who have not. I played with the questions constantly until I came to the decision that most of my questions would have to be based on the hopes that the students have participated in a science fair, since that is what my research question is based on. I left three questions in the survey for the students to answer if they have not participated in, one would only be able to be answered if they have not. The rest of the questions targeted the students who have participated in them before. The goal of my survey was to compare the number of students who have participated to the number of students who enjoyed participating in them. I also wanted to be able to see the change in their love for STEM before the science fair, and after. I hoped that my results from this survey would be able to match the research that had been done previously. After the survey was completed I brought them back home and placed all the data that was collected into graphs. I found that they were easier to look at as well as compare.

Phone interview with superintendent, this interview was done with a super independent that I have known since I was in elementary school. He has been the superintendent of the school district for over 30 years. I reached out to this individual because I knew with the amount of experience they have had they would be able to tell me all about their experience with science

fairs. I wanted to talk to him about the process of a science fair, who is involved, and where they get the fundings to host a science fair.

## **Results and Discussion**

Throughout my research from my literature review, interviews with a teacher and a superintendent, and student surveys, my findings have shown that there are many benefits to students who participate in a science fair.

1. What are science fairs, how did they come about, and how many types of science fairs are there? How do districts put together science fairs and are there resources available for school districts to plan, organize, and implement science fairs in their schools?

Science fairs are a way for students to showcase an experiment that they researched themselves to a broader audience. It allows the student to create a hypothesis, conduct an experiment, and showcase their results. Science fairs began in the early 1900s as a way to close the gap between scientific achievement and the public's knowledge of such achievements. They were created to allow students who were interested in STEM and were conducting their own experiments, to show the world their experiment and be rewarded for their hard work. There are usually two types of science fairs, engineering fair and a science fair. A science fair comes together thanks to the contributions of many individuals. The superintendent I interviewed told me that the very first science fair they held was an idea brought to them during a council meeting from a mother of a 10 year old. The people who are typically involved in the process of a science fair include; the superintendent, the principal, teachers, parents, judges ( usually those who are successful in a STEM career), and any other volunteers. Schools can get funding to put on a science fair through many organizations. There are programs that are dedicated to supporting and funding a science fair, as well as grants that can be given. When planning a science fair there are

many stems. The location of the science fair is typically in the school's cafeteria, or multi-purpose room. There are usually tables set up so that the students can place their projects and get them ready for display. There needs to be judges; according to Science Buddies, an organization that provides free science fair plans, “ you want to find judges who have a college degree in science, mathematics, or engineering and represent a diverse area of science” (ScienceBuddies 2008 P.8). Science fairs have been around for quite some time, they are put together by many individuals in a community. They are a great benefit for students to participate in, especially if they picture a career in STEM.

After knowing what a science fair is and how they are put together, I continued to research my secondary research question.

2. What does research say about the benefits of science fairs on students who are pursuing a career in STEM.

There are many benefits when it comes to science fairs, for starters students get to conduct their own experiments and show their results. Students are able to choose any project they want, they then have to practice the scientific method. They need to create their own hypothesis, conduct an experiment, review their results, and then present their findings. “The opportunity to be creative in sharing their work was cited as the reason for the popularity of these activities.” (Kelter & Schmidt, 2017, p.130). This quote is from a study done on science fairs and they impact on the students science inquiry learning and attitudes toward STEM.

3. What motivates students in getting involved in science fairs?

Participating in science fairs makes STEM fun, and they are able to experiment with different fields of science to find their favorite. The survey I conducted in the 5th grade class showed how science fairs really do help students find a love for STEM. There were 32 students

at the start of the survey, but only about 30 students were able to finish because most of the questions were about their experience in participating in a science fair. I wanted to see the number of students who got help on their project, since sometimes receiving help, especially from a parent, can lead to the students not being as motivated in doing the project. “ Projects are my chance to see them shine. They become so creative and cooperative, it's fun to see who leads and who doesn't” My 5th grade teacher said this in my interview with her. We talked about how the more the student does the project themselves, the more they enjoy it and get authentic experience from it (5th grade teacher, personal communication, 15 November 2022).

The next question I asked my students was how they would rate their experience during the science fair. None of the students gave it a 1 or 2, 3 students rated it 3, 15 rated it a 4, and 12 rated it a 5. (5th grade student survey, personal communication, 15 November 2022). This shows that science fairs are loved and enjoyed by many students. It is a great experience for students to be with their friends and practice STEM together. I then asked the students to rate their love for science before the science fair and after. Before the science fair there were 1 student who rated it a one, 6 who rated it a two, 15 rated it a three, and a few fours and fives. After the science fair there were 0 ones, 4 twos, 12 rated is three, 9 rated it a 4, and 3 fives. (5th grade student survey respondents, personal communication, 15 November 2022). So, as you can see there was a massive increase in the love for science after the participation in the science fair. This shows that science fairs really do benefit students in getting them involved in STEM.

My teacher mentioned to me that, “Students get to experiment with different fields of science to find which direction they are passionate about.” (5th grade teacher, personal communication, 15 November 2022). After she mentioned this we talked about how students get to choose which project they want to experiment and showcase. This allows students to try

different fields of science and see which fields they are passionate about. They also get to watch and listen to other projects by other students and see what fields others are interested in.

Sometimes other students' projects can inspire students as well, and they will be able to do a different experiment the next year.

4. Are there resources available for the school district to plan, organize, and implement science fairs in their schools?

During the interview with my superintendent we talked about how science fairs are introduced, funded, and conducted. He mentioned that the proposal of a science fair can be mentioned by any person involved with the school, whether it is a family member of a student, a student, a staff member, etc. (interview with superintendent, personal communication, 16 November 2022). He mentioned that their first science fair was from the ideas of a mother of a ten year old attending their elementary school. There are a few key components when it comes to organizing a science fair. Judges are needed in order to score the students science fair projects, it is a good idea to have the judges be someone with a professional background in STEM so the students are able to converse with a professional in the field they wish to pursue. There are also materials involved in creating a science fair project, sometimes with enough grant money the schools can provide the general materials such as; poster boards, markers, pens, glue, paper, etc. It is the students job to conduct the experiment and put together their presentation. "It is all based on the kids, in order to keep our science fairs up and running we depend on the students participation, so we try to make it as fun and smooth sailing as possible for them." (Super independent interview, personal communication, 16 November 2022). The more fun the students have the more likely they will be interested in STEM, and pursue a career in science, engineering, technology, or mathematics.



5. How are teachers involved in their student's participation in science fairs, and what rewards or future opportunities do they foresee their students receiving from participating?

Teachers can spend several weeks of class time devoted to helping their students with their projects, or any questions they may have if their project is done at home. They are also normally the supervisors when it comes to the science fair. "Since we don't have science fairs every year, I have only been involved in 4 science fairs since my time working here at this school." (Interview with teacher, personal communication, 15 November 2022). My teacher has worked at this school for 11 years, so on average that is one science fair every three years. By being involved, she would walk around and make sure that all the projects were neatly displayed, so they could be judged at their best. She was a supervisor during the science fairs to make sure that her students didn't run into any complications, and everyone was having fun. "I have personally witnessed science fairs be so beneficial to students, their eyes always light up when a judge comes up and says great things about their project, they seem so proud of themselves." (Interview with teacher, personal communication, 15 November 2022). Science fairs help inspire students to pursue a career in STEM. They give them an opportunity to conduct their own research and experiment, and showcase their results to their fellow peers and judges. They are also able to communicate with professionals in the STEM field, who do research for a living. Overall science fairs benefit students immensely and are a very enjoyable way for students to practice the scientific process, and experiment with different fields of STEM.

## **Problems and Limitations**

There can be a few problems when it comes to putting on a science fair, or even the students' experience in participating in a science fair. For starters, one of the main problems we run into when it comes to science fairs is the unfair advantages some students have over others. For example, there could be financial gaps between families that will allow students to make their projects visually attractive or even the materials the students use in creating their experiment. Another advantage difference could be the knowledge that the parents of the students have in the field of STEM. The more knowledge the parent has the more they are able to assist their child, or answer any questions the child may have. There are some scenarios where the parent steps in and takes over the project for the student, this does not happen often but when it does it takes away the fun and experience that the student gets from running the experiment themselves. Another problem that occurs when science fairs are happening is the amount of class time that is taken away to prepare or assist the students in their science fair. Jackie DeLisis, a research scientist at the Education Development Center has found that schools and families invest a lot of time and money in these fairs; “teachers may spend as much as six weeks of class time preparing for them.”(Levy, A, Delsi J, 2017). This is a lot of class time used for the science fair. Students miss out on other knowledge for other subjects, and it could affect them as they move on through the school year.

The last problem that has been noticed is that funding for science fairs is a lot, and having small participation makes it harder for the school district to continue them throughout the years. There are a lot of factors that go into the construction of a science fair, such as staff, awards, appetizers, and many more. Depending on the number of participants it can be even more

expensive than usual. If there is less and less participation then it makes putting on a science fair more of a burden on the school district than a fun activity for the students.

### **Recommendations**

I have some recommendations for helping to stop some of these common problems that occur when hosting a science fair. One recommendation is to get rid of the competition aspect, doing this would create a friendlier environment. It will also limit the parents' involvement and the competition to have their child present the “coolest” project. Getting rid of competition also creates a less stressful environment for the students, and makes participating in the science fair more fun and more memorable.

Another recommendation is to have the judges evaluate a student's project based on the scientific process being it rather than the way the project looks. One of the problems mentioned earlier was the unfair advantage of some students having more financials than others. The ones who have more financials usually have flashier projects which are more noticeable and more appealing to the eye. If the judges judge based on the students' experiment and their effort to find their solution or solve their hypothesis, then they will be rewarding their knowledge on the scientific process, not the way the project looks.

Another recommendation that will benefit science fairs is to provide students with rewards other than the ones they receive if they place. One of the problems mentioned earlier was that if there is limited participation then science fairs are too expensive to be annually. A way that could improve the participation in a science fair is if the teachers, especially if they are spending 6 weeks of their class time, give their students rewards that will benefit their grade. A great example of this is to give the students extra-credit, especially in a category like tests that

affect their grade drastically. Giving students reasons to participate, other than their love for science, increases the participation percentage by many.

### **Conclusion**

From my research, the results from the primary research question, “How do science fairs inspire students to pursue a career in STEM?” is that science fairs in fact inspire students to pursue a career in science, technology, engineering, and math (STEM). Participating in a science fair allows students to explore different fields in STEM and find their true passion. It also allows them to practice the scientific process of conducting an experiment. The student is able to choose which experiment they wish to conduct, create a hypothesis, conduct the experiment, summarize their findings, and then present their research to a knowledgeable audience. Science fairs are also a great opportunity for students to meet professionals in the field of STEM. Normally the judges in science fairs are professional scientists, or engineers and being there for the students to ask questions is a great opportunity for students to see which field they would consider to pursue.

Science fairs help students develop their critical thinking skills, problem-solving, time management, and communication skills. It also gives them experience that they can use later in life such as college applications, or even creating networks with future job opportunities. Research has been able to support my conclusion of the benefits that science fairs have on students and they should be provided to every student. By providing students with an opportunity to participate, schools are encouraging students to pursue their passions and/or even create new ones. The participation in a science fair needs to be encouraged and continues so future generations get the opportunity of enjoying science, and conducting personal research.

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Appendix A

[https://docs.google.com/forms/d/e/1FAIpQLSdMVAdbkhVYWWtaf3dE5k15DSTGdRK7L38THhgewRlxPERJCg/viewform?usp=pp\\_url](https://docs.google.com/forms/d/e/1FAIpQLSdMVAdbkhVYWWtaf3dE5k15DSTGdRK7L38THhgewRlxPERJCg/viewform?usp=pp_url)

What do you want to be when you grow up?

Your answer

Have you participated in a Science Fair?

Yes

No

What is a question you have researched, or would want to research in a Science Fair?

Your answer

Did you have help with your science fair project?

Yes

No

How would you rate your experience during the Science Fair?

1                      2                      3                      4                      5

What was the reward for the winner of the science fair?

Your answer

How would you rate your love for science before the science fair?

1                      2                      3                      4                      5

How would you rate your love for science after the science fair?

1                      2                      3                      4                      5

Appendix B

Interview with 5th grade teacher....

1. How many years have you been teaching?
2. Did you participate in any science fairs growing up?
3. How many science fairs have you been involved in since teaching at this school?
4. How does your school advertise to get students interested in Science Fairs?
5. What resources have you seen or know about that are provided to showcase a science fair?
6. What are some benefits you see students get out of participating in science fairs in the short term?
7. Have you seen an interest in STEM increase after a student participates in a science fair?
8. What are the benefits you see students get out of participating in a science fair in the long term?
9. Are there any rewards a student can earn for participating in a science fair?