Young Makers Compare Science Fairs and Maker Faires

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Introduction

Participation in the school-based science fair is ubiquitous to the middle-school student. Rising in popularity is the community based, extracurricular Maker Faire for the young tinkerer or maker. With this study, we share perceptions of these 2 canonical STEM events from the perspective of Young Makers. We report on the perceptions of science fairs and Maker Fairs from the perspective of 36 young Makers ages 7-18, who participated in a flagship Maker Faires in the United States. Using thematic analysis, we analyze their responses during qualitative interviews and report on their impressions of their science fairs and Maker Faires experiences.

Both science fairs and Maker Faires present authentic STEM (science, technology, engineering, and math) learning opportunities for the K-12 student. They have similar formats where the student presents work that they have done, both the process and end product or result. Opportunities often arise in both to engage and excite a student in an area of curiosity. Both types of fairs want their participants to interact with each other and provide each other with feedback and a learning environment. They also want the participants to document their projects.

Emerging themes indicate both similarities and differences and how those affect the projects represented in each. Both types of fairs are unique and provide a learning experience for their respective participants. Maker Faires may provide opportunities for schools to promote deeper learning.

Aims of Science Fairs and Maker Faires

An example of a science fair is the Intel International Science and Engineering Fair, around since the 1950s. ISEF materials define science fair as

> research [as]… a process by which people discover or create new knowledge about the world in which they live…Students design research projects that provide quantitative data through experimentation followed by analysis and application of that data.[1]

Specific learning objectives are learning the scientific method, answering a question, and communicating their research clearly. The science fair also offers an opportunity for feedback on how their project compares to others in a competitive school setting (with awards at the local, regional and national competition level).

Organizers describe Maker Faire as:

> part science fair, part county fair, and part something entirely new, …an all-ages gathering of tech enthusiasts, crafters, educators, tinkerers, hobbyists, engineers, science clubs, authors, artists, students, and commercial exhibitors.[2]

Maker Faires have become increasingly popular since inception more than 10 years ago, with attendance at flagship Bay Area Maker Faire reaching 130,000 and 85,000 at the flagship New York Maker Faire. Aims are promoting self-motivated learning; give makers a place to freely show of their project, and to have a transformational educational experience.

An increasing trend is bringing making activities to K-12 in the classroom, in collaborative maker spaces, and through clubs. This may allow for opportunities to benefit from both science fairs and Maker Faires, including a new initiative to have Maker Faires at schools. We will present implications for STEM and STEAM informal learning and means to engage in STEM, and particularly engineering, in and outside of the science classroom in K-12 education.

Research Questions

Given a population of young makers who participate in both science fairs and maker faire events, we are curious to explore the following research questions:

RQ1: What do young makers think about science fairs?

RQ2: Are they learning science concepts in their projects for Maker Faires?

These research questions are derived from a larger study on young makers and their motivations, knowledge and thought processes. This paper analyzes their responses applicable to science fairs and what they learned from their projects.

Research Methods

The study began by selecting young makers by the criteria that they are pre-18 and identified themselves as Makers. These selected individuals where then sought out at Maker Faires and asked to participate in this study. 36 agreed to be interviewed and 6-15 minute interviews were conducted in person at flagship Maker Faires[3]. Participant interviews were conducted at flagship Maker Faires as listed in the Tables 1 and 2.

Table 1: Numbers of Young Maker Interviews

Maker Faire	Bay Area 2014	New York 2014	Bay Area 2015
Number of Young Maker Interviews	12	15	9

Table 2: Demographic range

Age	7	8	12	13	14	15	16	17	18
Number of Makers	1	1	4	6	8	2	7	4	1

Table 2 shows the distribution of ages and grade level of the young makers who were interviewed. Effort was made to cover as ages as possible in order to get the best idea of what is happening at over the whole lifespan.

Interview protocol

Interviews where transcribed and analyzed with Nvivo using deductive coding. Specifically, for this paper the interview question and probes used focus on whether the young maker has participated in a science fair. Table 3 has an excerpt from the interview protocol.

Table 3: Example Interview Protocol

Example Question:	Have you ever participated in science fairs or competitions?
Example probe, if applicable:	How would you say Maker fair is similar and different to science fairs?

Our question was simple and straight forward. It did, however, allow Young Makers an opportunity to explain more thoroughly what their thoughts where.

Results

Of the 36 of young makers interviewed 14 said that they had never participated in a science fair before. 18 indicated that they had presented in a science fair and more interestingly 2 said that the project they brought to maker fair had previously been in a science fair. This is summarized in Table 4.

Table 4: Summary of Past Science Fair or Maker Faire Experience

Participated in:	Science Fair and Maker Faire	Only Maker Faire	Unsure	Used Same Project for both
Total Makers:	18	14	4	2

Several of the young makers who hadn't participated in a science fair gave a reason. One such maker said "No, my schools have never offered science fairs." Students who don't have the opportunity to do both should participate in the one that they have access to. Several of the Young Makers we asked to explain their thoughts on the difference between a science fair and a Maker Faire. One Young Maker said:

> Maker Faire, let's see. There's a lot more people that like to do that are here. Science fairs it's kind of like, you have to do it for school to get a good grade, but it's more people that are motivated themselves that make even better projects that you wouldn't think are possible. I think Maker Fairs are really cool in that way, in that if you want to participate you can. If you don't want to you can just walk around and look at other people's stuff. That's a good thing about Maker Fair, it's a lot of motivated people.

As the Young Maker says the motivation for science fairs come from the project being graded. Whereas Maker Faires are full of motivated people presenting the projects they are passionate about. This supports the conclusion that science fairs and Maker Faires are inherently different environments. Another Young Maker expresses that:

> …at Maker Faire people are more willing to talk about things, to share their designs, their projects with you rather than like at a science fair where you want to keep it to yourself

This collaboration aspect of Maker Faires makes them unique and increases their value in the classroom.

Analysis

Thematic analysis was used to best capture the similarities that come from the young Maker's responses[6]. Interviews where transcribed and the text analyzed in the Nvivo. The themes that emerge from the Young Makers explaining science fairs have deep implications. Competitiveness is the foremost of these themes. Young Makers often associate this competitiveness with a stifling of their creativity. They also feel it's a closed environment where they cannot share ideas openly.

Expected Projects

Maker projects and science fair projects can be very different in their nature. There is overlap and several of the young makers presented the same project at both fairs.

The quintessential science fair project is something like a model volcano, science fair projects synthesize experimental data the student has generated into a quick presentation focused on delivering it in a short timeframe. The Intel Science fair handbook outlines the process for a science fair project in 9 steps[1]. The first 3 steps deal with picking the topic. They say Step 1:

> Get an idea of what you want to study or learn about. Ideas should come from things in your areas of interest. A hobby might lead you to a good topic. What is going on in the world that you would like to know more about? Most importantly, pick a question or problem that is not too broad and that can be answered through scientific investigation"[1] (p. 2).

The important concept is focused on is that last sentence, picking a topic that is not too broad. Science fair topics are intended to teach student science concepts.

Maker projects are more difficult to quantify because they can be anything from a smart watch to light up dress and everything in between. Generally, the projects consist of subjects that the young maker is interested in learning more about. In the Makerspace Playbook it outlines how to pick a project. The first step is to pick a mode of inquiry. These modes of inquiry being skills, tools, materials, and multi-domain projects[4] (p. 26). By choosing a subject area that they are interested in learning Young Makers can keep up the enthusiasm to complete the project and go above and beyond.

Organizational Structure

Maker Faires and science fairs differ in their setup in a multitude of ways. Science fairs are often grade or age specific and have criteria for the projects that are submitted. Maker Faires are open to everyone who wants to exhibit and have few rules for the projects that are displayed. For example, the National Intel Science Fair had a set of criteria 4 pages long for the projects. "A glance should permit anyone (particularly the judges) to locate quickly the title, abstract, experiments, results and conclusions" is an example of the requirements for a project[1] (p. 4). On Maker Faire's website[2] they don't list rules and instead ask for topics they would like to see covered; "Your application is reviewed for safety." Science fairs are often competitive and there is a next level or prestigious awards. Maker Faires do have a small blue ribbon award that is given out but it is not competitive and there is no selective next level. This difference especially impacts the overall social environment of the event.

Advantages of Maker Faires

The atmosphere surrounding the Maker Faire creates different opportunities than a science fair, these differing opportunities are an advantage of Maker Faires. Maker Faire projects are often self-motivated and with fewer requirements than a science fair young makers can pick a project that reflects exactly what they are interested in and not what education dictates,

> We are particularly interested in how our approach might reach students who don't fit well into the existing system or who have already dropped out of it[2] (p. 10).

Since the environment is collaborative rather than competitive young makers can bring half-finished projects to show and get advice on. This creates the opportunity to work with other makers from all ages and all backgrounds. These cross-discipline interactions can enhance the young makers social and teamwork skills.

Advantages of Science Fairs

Science fairs have a very different atmosphere which has its own advantages. The anxiety created by a science fair[5] can be helpful for the students. This study showed that science fairs helped kids realize where the anxiety comes from and that after going to many science fairs they can better handle the stress of presenting." In this context, recurring participation emerges as an effective strategy for coping with this feeling"[5] (p. 1). Science fairs also present the opportunity for students to learn about the world around them in a structured way. It can also give them hands on learning experience. The competitiveness of science fairs and short time period teaches kids the importance of time management and gives them a scenario to practice time management skills in. On the subject of procrastination one study member said "which is very bad because at the last minute, you never perform your best and provide the high quality of work that you should. And so... my advice is not to procrastinate in those situations"[5] (p. 40). Giving students an opportunity to practice these skills in a low stakes situation helps students see the value in the skill.

Social Scheme for Sharing Knowledge

They do have a few similarities in some aspects such as that they are both open to the public. They both provide a social scheme for sharing of knowledge. Each fair has multiple sizes that they are hosted in, for example there are Mini Maker Faires, which are more localized, and science fairs are often school location based. Students can learn similar skills at each fair depending on the projects they set out to present.

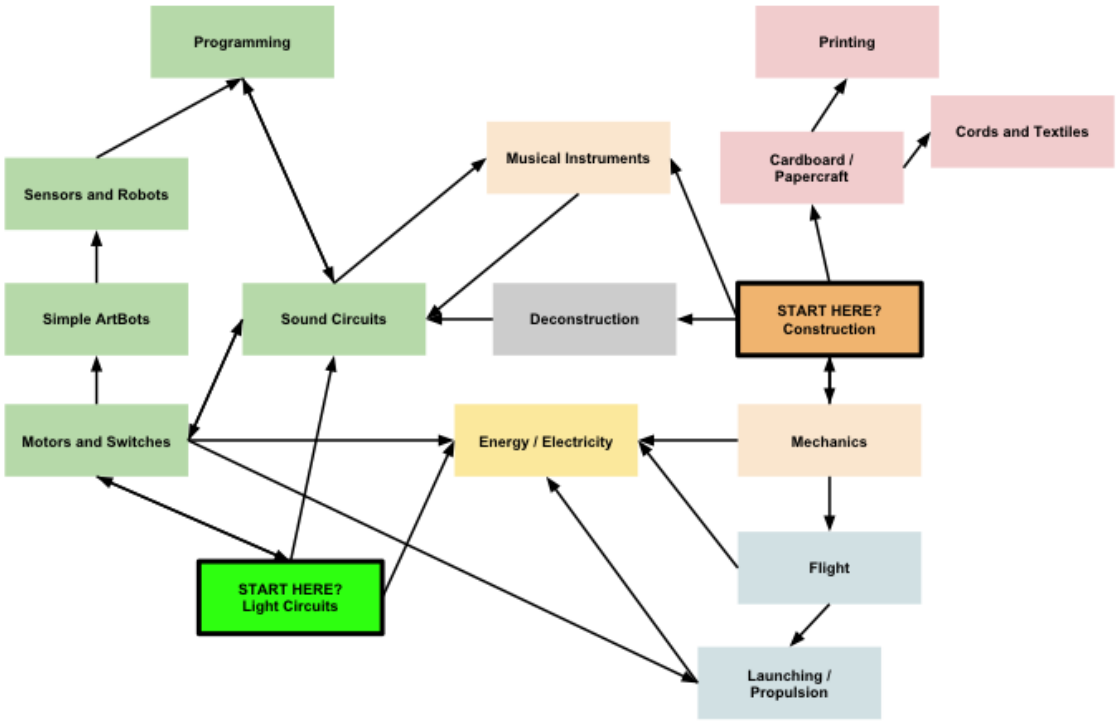
Learning Objectives

Both science fairs and Maker Faires want their participants to learn, that is their goal. Both of these fairs offer great opportunities to learn but they do it in differing ways. Science fairs are very focused on the scientific community and are used to teach students about the scientific method in a structured and practical way. Step 8 of the scientific process s outlined by the Intel Handbook says "Review and discuss the findings with peer group/ professional scientists"[1] (p. 1). Below is a graphic from Intel's Science Fair Educator material, which details their version of the scientific method.

In Figure 1, the scientific process is linear with one route for iteration. It is also notable that whether the hypothesis correct or false you are expected to report those results. Maker Faires' learning objectives are similar but the way the student reaches them is different. As Figure 2 shows there are a multitude of paths to get to each node, there are also two different starting locations. As the diagrams illustrate the paths a student can take are very different. Another difference of note is that the text in the squares are very different. The scientific process focuses on processes that are needed to conduct the experiment and what to do with the data. The Making diagram has skills that the student needs to learn in order to do the project. These differences summarize the why the actual projects are so different.

Figure 1: Scientific Method from [1]

Figure 2: Make Learning Objectives, from[2] (p. 25)



Discussion

How can Maker Faires and science fairs be used together?

The main advantages of each could potentially be combined into one fair type. Have the openness and freedom of a Maker Faire but add the time management of a science fair. Structured in the right way this may become a better way to teach kids concepts than just a science fair or Maker Faire.

How well would a Maker Faire translate into the classroom?

There would be a few challenges to overcome first. Maker Faires allow the freedom to make just about anything but in a classroom environment resources are much more limited. Kids might also have no idea what they want to make or are not motivated to work on anything. In these cases, the teacher may be able to help kids pick a project they are motivated to do. But in some situation there are too many students to have significant one on one time with students since deciding on projects can take some time. Maybe a questionnaire asking thought provoking questions could be implemented to help get kids thinking about projects on their own. In a science class most kids come up with their own idea and simply take it to the teacher for approval. This could similar to how a Maker Faire could be run just with different goals guiding the projects.

Who would lead the rise of Maker Faires in the school setting?

Currently most science fairs are organized and facilitated by the science teachers. A Maker Faire is a bit different in the types of projects that are done. The hands on fabrication projects typical of Maker Faire would cater more towards the shop teacher, the robotics club advisors or the programming instructors, or potentially all three. Not to say the science teacher cannot help with a Maker Faire, an enthusiastic teacher no matter the subject can work wonders. These teachers have experience facilitating kids on hands on projects that are often self-motivated by the kids.

Conclusion and Next Steps

Maker Faires and science fairs each present a unique opportunity for students. The themes that emerge seem to imply that Maker Faires are a better environment for learning lifelong skills. Maker Faires give a much more pronounced opportunity to collaborate across a multitude of disciplines and backgrounds. Young Makers see big differences between science fairs and Maker Faires and each have their own benefits. These benefits manifest in the knowledge that is gained by the individual. It would be advantages to combine Maker Faires and science fairs into a new fair that has the learning benefits of both. This hybrid model will be facilitated by new roles not currently associated with Maker Faires or science fairs.

Further research could be done on the science fair side. An interesting direction would be to interview science fair students about their thoughts on Maker Faires. The themes of how they feel about Maker Faires could parallel the themes in this study or they may be opposite. Some teachers may already be trying to incorporate Maker Faires into schools or modifying their science fairs to be more like Maker Faires. A study could be done on these fairs and the teachers interviewed about how they did it and how it went. Combining all these studies into one paper could create a powerful tool for helping our education system better prepare our students for the future.

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