The Future of
Engineering Education
2024 Annual Conference & Exposition

Oregon Convention Center
Portland, OR . June 23 - 26, 2024

ASEE

Paper ID #41729

From Science Fair to STEAM Night

Dr. Shannon L. Isovitsch Parks P.E., University of Pittsburgh at Johnstown

Dr. Shannon Parks is a registered Professional Engineer with 20+ years of broad-based experience in the water resources and environmental engineering fields. She holds a Bachelor of Science Degree in Civil Engineering from the Pennsylvania State University and a Masters of Science and doctoral degree in Civil & Environmental Engineering from Carnegie Mellon University. She has been teaching water resources and environmental engineering at University of Pittsburgh at Johnstown since 2016. Prior to joining University of Pittsburgh at Johnstown, Dr. Parks worked for over seven years at the Alcoa Technical Center focusing on development and commercialization of sustainable wastewater treatment and solid waste reuse technologies. She also served as a member of the Alcoa Foundation Board of Directors, providing environmental expertise to support the Foundation's focus areas of Environment, Empowerment, and Education, as well as her experience with science, technology, engineering, and mathematics (STEM) education for women. Prior to joining Alcoa, Dr. Parks worked for approximately seven years as a consultant to government agencies, municipalities, and industrial clients performing water resources engineering design and permitting. In addition to her corporate experience, Dr. Parks served as a Peace Corps Volunteer in Mali, West Africa, supporting a local Non-Governmental Organization on water sanitation projects.

Mrs. Larissa Yates, Buffalo Elementary Parent Teacher Organization
Emily Geist
Sara Ruffner

From Science Fair to STEAM Night (Evaluation)

Abstract - Science fairs have a long history of engaging students in scientific exploration with friendly competition. However, in recent years with the promotion of integrating Arts into STEM, STEAM Nights have become popular. This is particularly true at the primary level where very young students can be engaged in all aspects of STEAM activities. This paper discusses an elementary school's transition from a grades 3-5 science fair to a grades K-5 STEAM Night. The science fair had been held for 29 years at the school, with a maximum of about 75 students participating each year. STEAM Night has now been held twice, with an estimated 100 students attending each time with their families. A survey of STEAM Night participants indicated that the event was enjoyable and educational and that most prefer it to a science fair. However, a survey of all school families indicated a preference for a science fair. Advantages and disadvantages of both science fairs and STEAM nights are discussed as well as recommendations in developing a successful STEAM Night.

Introduction

Science fair participation is a tradition for many students, especially at the middle and high school level, where various aspects of the benefits in participation in science fairs have been considered. In a study of high school students Grinnell et al. [1] recommend that science fairs be voluntary and that a non-competitive option be provided to increase participant interest in science or engineering. In a further study, Grinnell et al [2] show that most high school students who participate in science and engineering fairs are from suburban schools and very few are from rural schools. Finally, different approaches to science fair implementation in middle schools, such as teacher support or required participation, were considered by Kook et al. [3].

While research has been completed on high school and middle school science fairs, little formal research has been completed on elementary school fairs. Studies that do focus on elementary fairs still tend to be for children ages 10 and up [4]. At the same time, science fairs have become more common in elementary schools to encourage interest and learning in STEM (Science, Technology, Engineering and Math) at an earlier age. Elementary science fairs vary in implementation and desired results. Some fairs more closely represent a research project and allow students to gain fluency in a scientific topic and practice presenting the topic to others. Other science fairs have a more competitive feel with awards for innovative experiments, sound scientific methods, or impactful results.

Some STEAM (Science, Technology, Engineering, Art and Math) events take the format of a traditional science fair, where students develop experiments and present, but integrate arts and creativity. These tend to still be focused on students ages 10 and up [5] [6]. Alternatively, STEAM Nights tend to be family events where attendees visit various booths to conduct hands-on activities appropriate for all ages. These nights are an opportunity for students and their

families to engage in a plethora of hands-on, mind-on activities. They ignite an interest in academic areas that perhaps students would not typically be interested in or deepen an already found passion. STEAM Nights are generally set-up as an open house style event where students and families come and go as they wish. Activities are set-up in a way that families can participate without having any background knowledge. Some examples of STEAM activities are science experiments, coding robots, engineering challenges, art creations and math games. Activities could be set-up as a learning station where students make a hypothesis and are then able to test their theory. Activities could also be set-up as challenges where students create something based on a selected list of materials and restraints. The activities could be delivered by students, parents, teachers, community members and/or professionals. STEAM events should promote exploration, creation, and discovery.

STEAM Nights allow families to interact with stations and activities at their own pace. They promote parental involvement and reinforcement of skills. Parents become participants with their children, modeling for them the curiosity and excitement of discovery and learning. All of this is essential for support of elementary school teachers [7]. Emphasizing arts and creativity in STEAM projects can engage students deeply while fostering risk-taking, experimentation [8], cognitive skills, communication skills, and collaboration skills [9].

While change from traditional educational practices is difficult, it is necessary for students. Some educators have noted that traditional science fairs have become antiquated, tedious, and developmentally inappropriate for children under the age of 11, whereas STEAM events allow for more creativity in students' learning resulting in happy, confident learners [5]. This paper discusses an elementary school's transition from a grades 3-5 science fair to a grades K-5 STEAM Night. STEAM Night attendees were surveyed as to their perceptions on the event, and the entire school was surveyed on their preferred family events. Advantages and disadvantages of both science fairs and STEAM nights are discussed as well as recommendations in developing a successful STEAM Night.

Methods

Science Fair

The elementary school that is the focus of this study, has 580 students and houses grades kindergarten through fifth grade. It is considered an above-average public school with a student-teacher ratio of 16 to 1 [10]. The school administration, teachers, and staff work closely with a very active Parent Teacher Organization (PTO) that has organized the science fairs and STEAM Nights. The PTO has approximately 150 members.

The elementary school conducted a science fair for 3rd, 4th, and 5th grade students for 29 years, until it was abruptly canceled in 2020 due to the COVID-19 pandemic and associated quarantine. The fair was voluntary, and the participation rate varied. In the last few years of the fair, the

participation rate reached approximately 25% of the eligible students, or 75 students each year. This final participation rate was an increase because of several changes enacted in the program:

- participation prizes were added,
- judging of the student projects was completed by local science and engineering professionals,
- an awards ceremony was held based on judging results, and
- in-school viewing of the projects was incorporated into a day of science themed activities for the whole school.

Parent volunteers would visit classrooms of eligible students to discuss the fair, explain the fair using past project examples, promote excitement around the science fair, and answer questions. Teachers were not asked to supervise projects and no in-school time was allotted for project completion.

STEAM Night

STEAM Night was organized as a family event held at the elementary school in the evening. Families visited various areas of the school (i.e. gym, library, auditorium) where 2-3 activities or demonstrations were held for each STEAM category (i.e. Science, Technology, Engineering, Art, and Math). The activities and demonstrations were led by parents, teachers, community members, and organizations. The result was a combination of stakeholders involved in the event.

To encourage the students and families to participate in every STEAM category, a "STEAM Night Passport", as shown in Figure 1, was developed and given to each student on a lanyard. Each student who completed their "Passport" with a sticker from each station, collected a STEAM craft, toy, or game as they were leaving the event. This information was communicated to the parents and students by greeters as they arrived. A map of the school was also presented with certain areas highlighted where they could stop for each station.
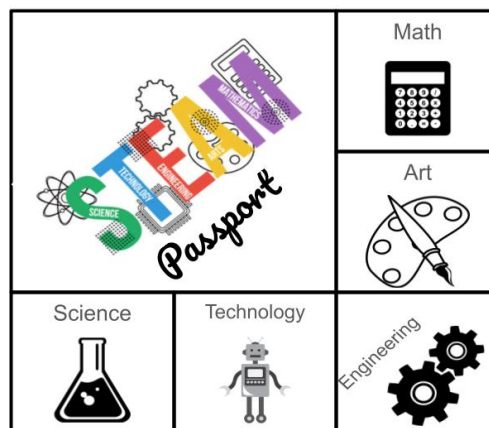

Figure 1: STEAM Night Passport.

Along with the STEAM stations, the event also had a concession stand, local snow cone truck, and a basket raffle. These additional items enticed families and students to stay at the event a little longer and complete as many stations as they wanted. An example of activities held at STEAM Night are summarized in Table 1 and shown in Figure 2.

Table 1: Example STEAM Night activities and demonstrations.

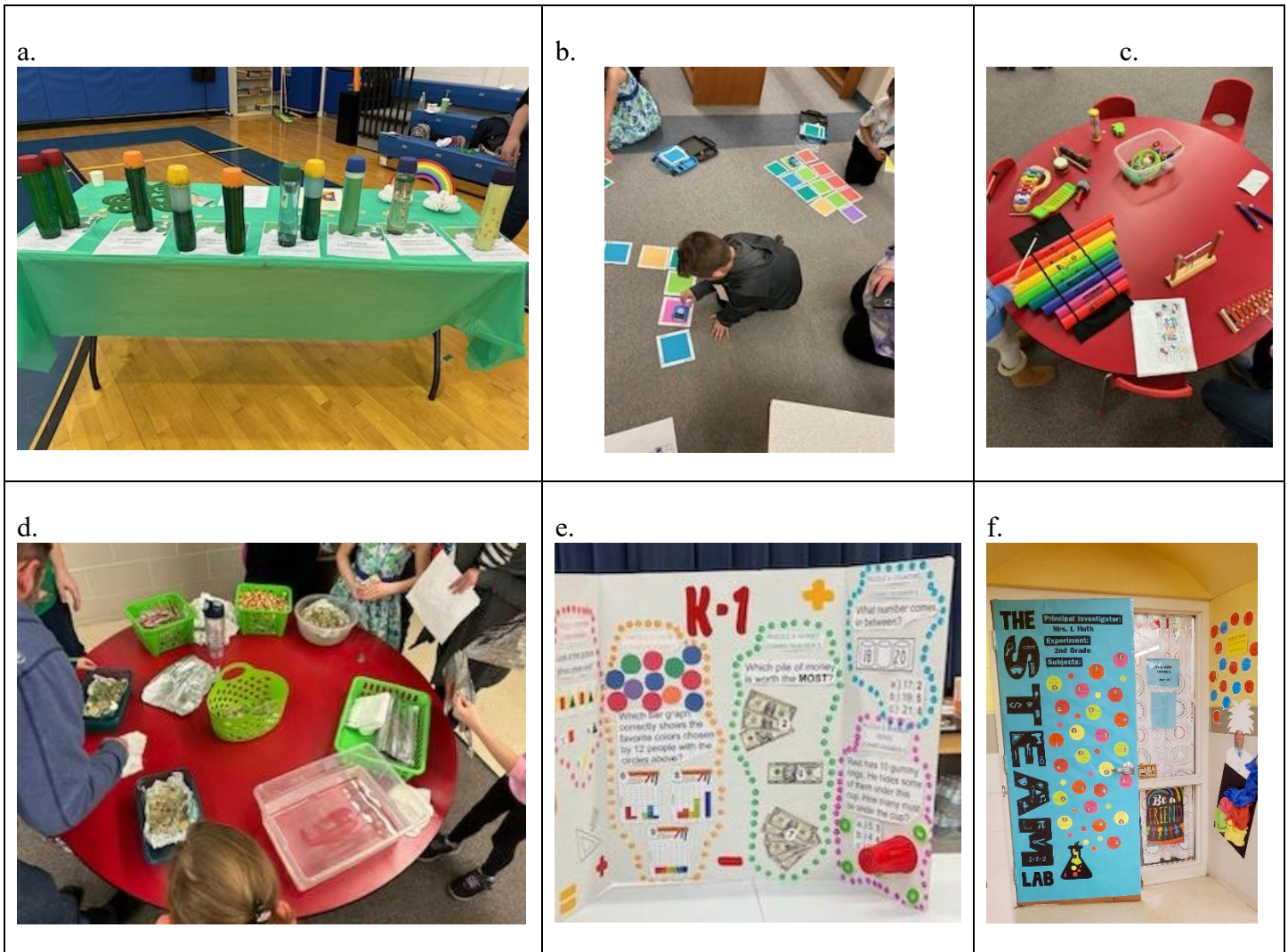| Science	Technology	Engineering	Art	Math
Fluid Properties demonstration: Set of playable bottles that demonstrate topics like suspension, viscosity, magnetism, and hydrophobic principles (Girl Scouts)	A demonstration of MakerSpace robots for coding (teacher)	A hands-on demonstration on testing water quality and dialogue with an engineering professor (parent)	School-wide art project (teacher)	Math Escape Room with three different activities to be completed at different grade-levels (parent and teacher)
An FBI Finger-Printing Station and dialogue with a State Trooper (parent)	A demonstration of Combat Robots (BotsIQ) (teacher)	Sustainable Development Goals Shoots-and-Ladders game [11] (parent)	Musical instrument station (Kindermusik)	
An interactive race involving balloon physics (parent)		Buoyancy activity (community member)		
Live owl demonstration (Audubon Society)				
A hands-on kitchen science activity (parent)				

Figure 2: STEAM Night activities: a.) Fluid properties b.) MakerSpace robots c.) Musical instruments d.) Buoyancy e.) Math Escape Room f.) Door decorating

Data Collection

A paper survey was provided to adult participants at the end of the second STEAM Night (see Appendix). It asked for general information on the person completing the survey such as if they were a teacher, parent, station presenter, PTO volunteer, school staff, and/or STEAM professional. It also asked if they had participated in a STEAM Night and/or Science Fair in the past. Next, the survey asked the following 11 questions about their perceptions of the effectiveness of that STEAM Night with a 5-point likert scale:

1. This STEAM Night event was presented in an organized manner.
2. The Station Presenters were knowledgeable on the topic.
3. The Stations were age appropriate for a K-5 grade school.
4. The Stations were educational.
5. The Stations were interesting and enjoyable.
6. The Stations helped to inspire an interest in Science, Technology, Engineering, Art or Math.
7. I would be interested in attending a similar event next year.
8. I recommend this STEAM Night event to other families.
9. I recommend a similar STEAM Night event to other elementary schools.
10. I prefer STEAM Night to a Science Fair for K-5 grades.
11. I prefer a Science Fair to STEAM Night for K-5 grades.

The last question was reverse coded compared to question #10 to reduce response bias. Of the 23 responses received, three were removed from analysis due to questions #10 and #11 being answered the same. Although one respondent did not answer questions #10 and #11, this record was still included in the analysis.

A separate survey was sent to all families, teachers and staff from the elementary school asking them to select from a list of family events that they would be interested in attending. Thirty-one events were listed, including science fair and STEAM Night, as well as space to add a new idea.

Results and Discussion

All 20 STEAM Night survey respondents were parents; one was also a teacher, and four were also PTO volunteers. 12 respondents were not STEAM professionals; two held professions related to technology, two related to engineering, and one each related to math and science. One respondent held a profession related to both technology and math and one held a profession related to science, technology and engineering. 13 respondents attended a STEAM event in the past, and seven attended a science fair in the past. Five respondents attended both a STEAM event and science fair in the past.

Figure 3 shows that participants in general responded favorably to the event, with questions 1-9 all scoring with an average of 4.4 or higher. Question 8 scored highest with an average of 4.75 indicating that most respondents agreed to a very high degree that they would recommend this STEAM Night to other families. Questions 3, 5, and 7 all scored with an average of 4.7. Nine respondents were neutral (score of 3 on questions #10 and #11) on whether they preferred STEAM Night to a Science Fair for K-5 students, and 10 respondents preferred STEAM Night (1 did not respond).
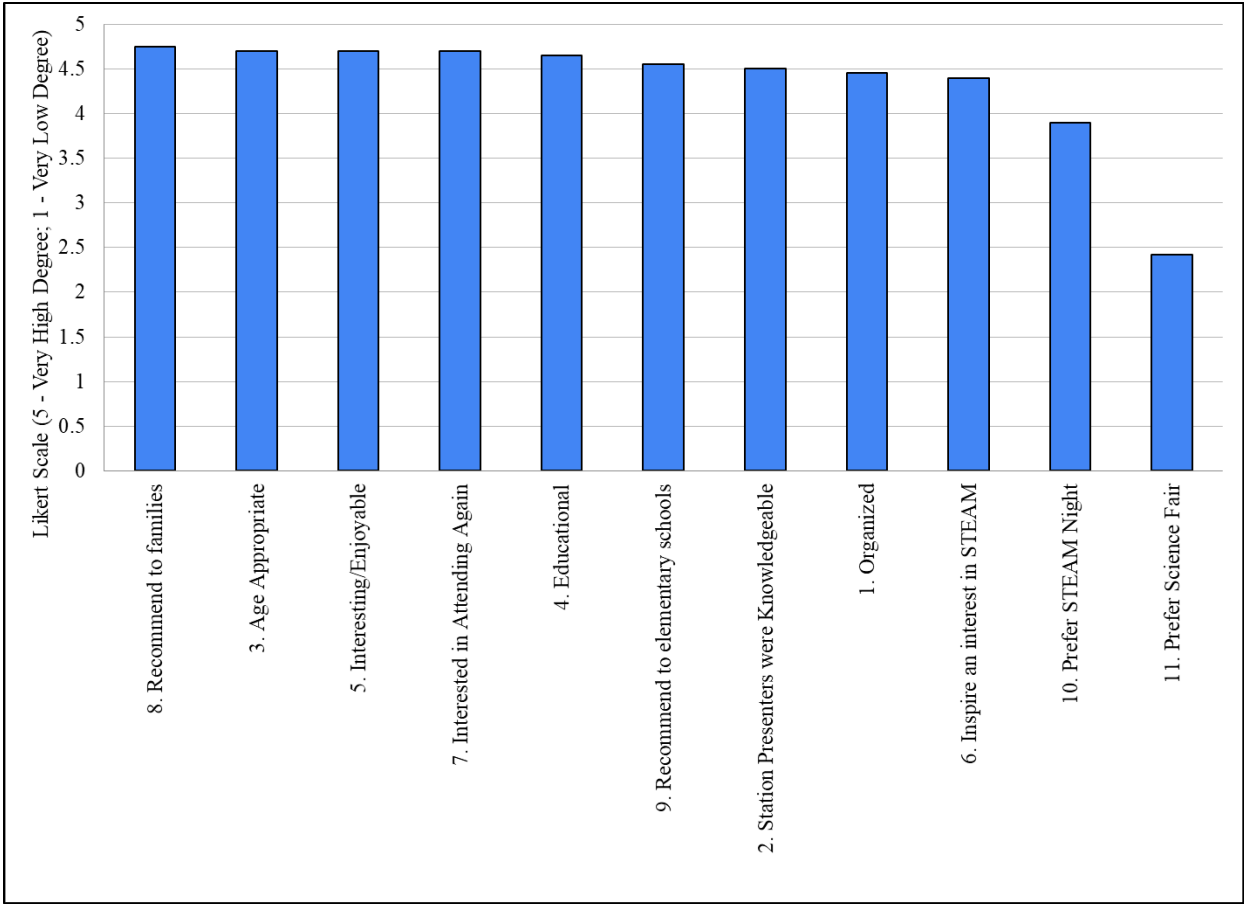
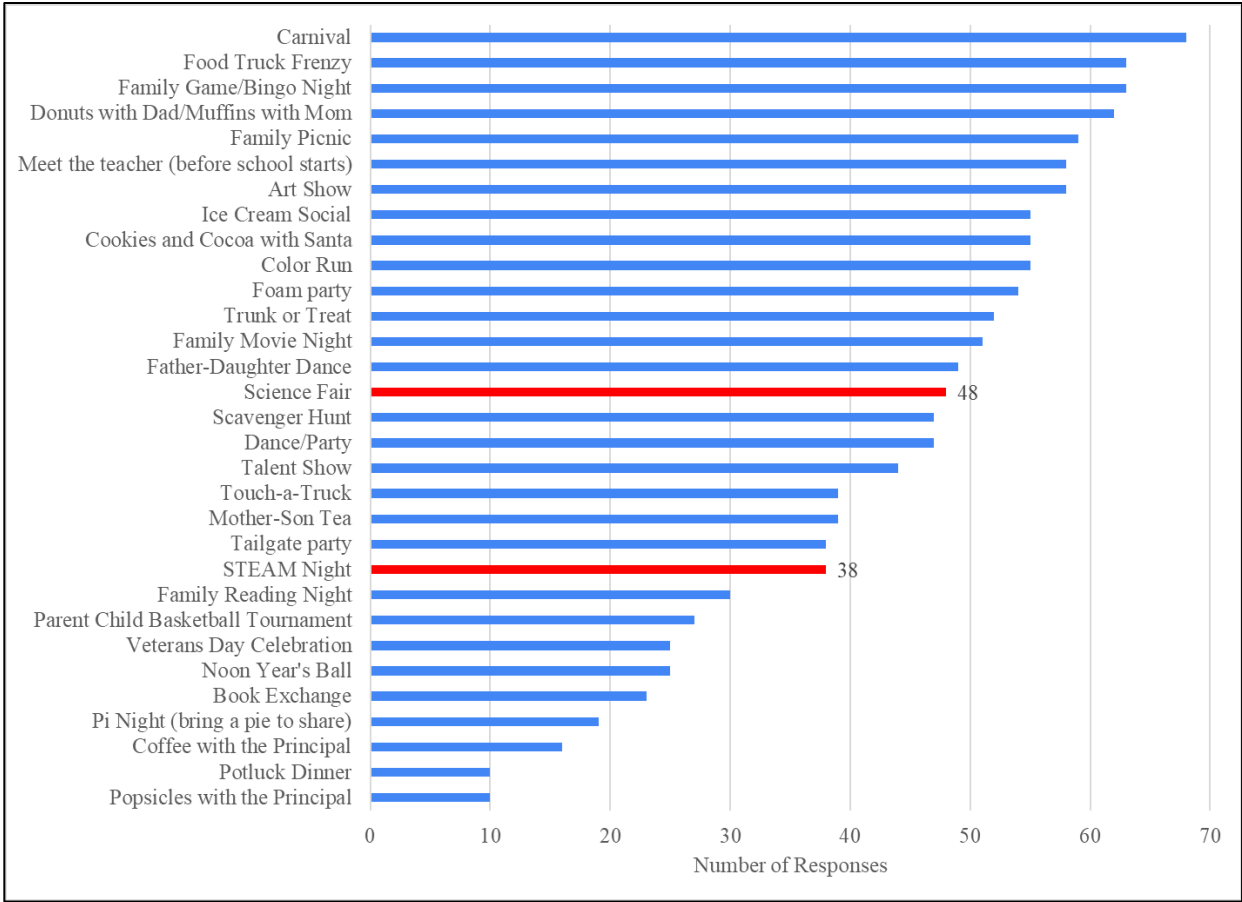**Figure 3: Summary of Survey 1 - STEAM Night Participant Perceptions**

Figure 4: Summary of Survey 2 - Family Preferences for After-School Events

Table 2: Survey 2 Response by Participant Roles and Child Ages

Response	Parent	Parent & Staff	Parent & Teacher	Parent & Teacher & Staff	Staff	Teacher	Grand Total
Neither SF nor SN	56	2	1		4	7	70
Grades 3-5	21	1	1				23
Grades K-5	13						13
Grades K-2	21	1					22
N/A	1				4	7	12
BOTH SF & SN	21	1			1	1	24
Grades 3-5	6	1					7
Grades K-5	10						10
Grades K-2	5						5
N/A					1	1	2
Science Fair	18		2	1		3	24
Grades 3-5	3			1		1	5
Grades K-5	7		1				8
Grades K-2	8		1				9
N/A						2	2
STEAM	12	1				1	14
Grades 3-5	3	1					4
Grades K-5	3						3
Grades K-2	6						6
N/A						1	1
Grand Total	107	4	3	1	5	12	132

One hundred thirty-two responses were received from the second survey, with 81% of respondents being parents, 9% teachers, 4% staff, and 6% held multiple roles as shown in Table 2. Figure 4 illustrates that more respondents indicated interest in attending a science fair (36%) than STEAM Night (29%), though neither ranked highly. Science fair ranked 15th of the 31 given event ideas, and STEAM Night ranked 22nd. Only one event (Carnival) received at least half of the votes (68 of 132 or 51.5%). Of the 31 events included in the survey, the school currently only holds STEAM Night and Family Reading Night (ranked 23rd).

Half of the teachers who responded did not choose science fair or STEAM Night; 38% of teachers chose science fair; 6% chose STEAM Night; and 6% chose both. Over half of the parents who responded also did not choose science fair or STEAM Night; 17% choose science fair; 11% chose STEAM Night; and 19% chose both.

Conclusion

While science fairs have become a traditional method of engaging pre-college age students in STEM, their applicability to elementary-age students seems limited. Meanwhile, there is more and more interest in engaging elementary-age students in STEM education. Integrating the arts into STEM, to create STEAM activities can help to engage young children in creative scientific discovery, technology and engineering application, and math. However, change from traditional practices is challenging to implement.

After a 3-year hiatus on the traditional elementary school science fair due to the COVID-19 pandemic, the PTO decided to come back with a STEAM Night instead. The science fair had focused on grades 3-5, where STEAM Night was appropriate for the whole school and even younger siblings.

Survey results indicate that while STEAM Night participants found the event enjoyable, educational, and would recommend it, the overall school community prefers a science fair if given a choice between the two. However, given other choices, the community appears to prefer non-academic events such as a carnival or game night.

Science fairs are a great way to introduce the scientific method, research, and discovery to students. They promote curiosity while providing an opportunity to learn standard data collection and analysis techniques, as well as presentation skills. It has been recommended that science fairs be voluntary for students to increase engagement. However, it is challenging to engage students not already predisposed to STEM fields in science fairs.

STEAM Nights are a way to engage students at a younger age with hands-on activities, while also taking the burden from parents to help their child with a science fair project. Families can move through STEAM activities at their own pace with parents learning alongside their children. If a family is interested is developing a project in more detail like they would for a science fair, they can sign up to run a booth at STEAM Night.

Limitations to the study include the small sample size of STEAM Night participants who responded to the survey. Also, no study was done to determine actual effectiveness of STEAM Night on learning or promoting interest in science, technology, engineering, art, or math. Despite its limitations, this study provides an example of how to successfully hold a STEAM Night at an elementary school, engaging parents, teachers, and community members, while also showing evidence of the challenges that come with change, such as overall family preferences.

References

[1] F. Grinnell, S. Dalley and J. Reisch, "High school science fair: Positive and negative outcomes," *PLoS ONE,* vol. 15, no. 2, 2020.

[2] F. Grinnell, S. Dalley and J. Reisch, "High School Science Fair: School Location Trends in Student Participation and Experience," *PLoS ONE,* vol. 18, no. 9, 2023.

[3] J. F. Kook, J. DeLisi, E. T. Fields and A. J. Levy, "Approaches for Conducting Middle School Science Fairs: A Landscape Study," *Science Educator,* vol. 27, no. 2, pp. 71-80, 2020.

[4] E. Kyriazi and C. P. Constantinou, "The Science Fair as a Means for Developing Children's Graphing Skills in Elementary School," in *1st International Conference on Hands on Science*, 2004.

[5] D. Rufo, "STEAM-ing up the science fair," *Art Education,* vol. 69, no. 4, pp. 12-16, 2016.

[6] M. Caplan and E. Oropeza, "The STEAM Conference: An Event to Promote Youth to Explore STEAM related Fields and Potential Careers," in *2019 ASEE Annual Conference & Exposition*, Tampa, FL, 2019.

[7] J. Klar, "Mentoring Teachers in STEAM Improves Likelihood of Application," 2018.

[8] D. Rufo, "STEAM with a capital A: Learning frenzy," *The STEAM Journal,* vol. 1, no. 1, p. 25, 2013.

[9] G. Šmitienė and K. Kesylė, "Opportunities for the use of STEAM projects in primary years classes: the points of view of international baccalaureate teachers," *Regional formation and development studies: journal of social sciences,* vol. 2, pp. 198-205, 2022.

[10] Niche.com Inc., "Niche," 2024. [Online]. Available: https://www.niche.com/?ref=k12. [Accessed 05 02 2024].

[11] Nations Unies, "Go Goals," [Online]. Available: https://go-goals.org/. [Accessed 06 02 2024].

Appendix - STEAM Night Evaluation

You are invited to provide feedback on the effectiveness of the 2023 PTO STEAM Night to inspire interest in science, technology, engineering, art and math in K-5 students. We hope to use this information to improve our events and to enhance student learning and engagement. In addition, we will share the aggregate results in presentations and/or publications. If you are willing to participate, this questionnaire will ask about *your perception on STEAM Night.* It will take you approximately *two* minutes to complete. There are no foreseeable risks associated with this project, nor are there any direct benefits to you. This is an entirely anonymous and voluntary questionnaire, and so your responses will not be identifiable in any way. All responses are confidential. By completing this survey, you are agreeing that you are at least 18 years of age.

Check all that apply:

I am a: ☐Teacher ☐Parent ☐Station Presenter ☐PTO Volunteer ☐School Staff ☐Other

I am a professional in a STEAM related field:
☐No ☐Yes, Science ☐Technology ☐Engineering ☐Art ☐Math

I have attended a STEAM Night event in the past: ☐No ☐Yes

I have attended a Science Fair event in the past: ☐No ☐Yes

Rate the degree with which you AGREE with each statement.	very low degree	low degree	neither low nor high degree	high degree	very high degree
1. This STEAM Night event was presented in an organized manner.					
2. The Station Presenters were knowledgeable on the topic.					
3. The Stations were age appropriate for a K-5 grade school.					
4. The Stations were educational.					
5. The Stations were interesting and enjoyable.					
6. The Stations helped to inspire an interest in Science, Technology, Engineering, Art or Math.					
7. I would be interested in attending a similar event next year.					
8. I recommend this STEAM Night event to other families.					
9. I recommend a similar STEAM Night event to other elementary schools.					
10. I prefer STEAM Night to a Science Fair for K-5 grades.					
11. I prefer a Science Fair to STEAM Night for K-5 grades.					