The Value of Science Fair and the Factors that Have Led to the Decline in Ohio Science Fair Competition

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ABSTRACT

This study seeks to identify the reasons for the decline in science fair participation, ascertain educators' views on the value of science fair as a curriculum tool to teach state science standards and assess the importance and relevance of science fair in today's science curriculum. The Ohio Academy of Science (OAS) provided state data showing the downward trend with 4,886 students participating throughout the state in 2001 and falling to 2,669 in 2015. Both the state and OAS science standards are modeled after the Next Generation of Science Standards set forth by the National Resource Council. This inclusion of science fair in the science curriculum fulfills the requirements set forth in the current Ohio Learning Standards in Science comprising project-based learning and 21st Century Skills. With the current standards changing to reflect all objectives and pedagogy of a correctly modeled science fair, it was surprising to see a decline rather than an increase in science fair participation.

A survey was constructed to find why science fair was on the decline and not being implemented, to determine if educators valued its worth, what they perceived necessary for a successful science fair, and if science fair satisfies the state standards.

The salient findings of the District 15 survey mirrored those of the state and district in participation rates. The results also showed educators placing a high value on science fair along with identifying obstacles that impede its enactment. The leading obstacles are lack of time and finances, too much emphasis on testing, too many teaching duties, and unfamiliarity with its implementation.

This study also offers a practical solution to the major concerns of educators regarding the implementation of science fair.

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CHAPTER I

INTRODUCTION

Statement of the Problem

Including science fair in the science curriculum fulfills the requirements set forth in the Next Generation Science Standards (Appendix A) presented in the Framework for K-12 Science Education (NRC, 2012) and the adoption of the 2010 Ohio Learning Standards in Science (Appendix B), fully implemented in the 2014-15 academic year, promoting the use of inquiry-based and project-based science instruction.

Since 1891 the Ohio Academy of Science (OAS) has been the leading organization in Ohio to promote science and science education. Its mission is to foster problem-solving skills in Ohio (OAS, 2015). The OAS hosts an annual science fair competition for all 17 districts in the state. District 15 encompasses four counties including Ashtabula, Columbiana, Mahoning, and Trumbull. Over the past fifteen years a steady decline in science fair participation in Ohio, at the district and state level has been observed and documented by the District 15 Science Day Council. District 15 Science Day that once boasted more than 600 students in the late 1990s, has currently fallen to just over 91 in 2017. Annual reports from all seventeen districts in Ohio for the past fifteen years serve as the source of data (Appendices D and E). This study seeks to identify the reasons for the decline in participation, ascertain educators' views on the value of science fair as a curriculum tool to teach the science standards, and assess the importance and relevance of science fair in today's science curriculum.

The Ohio Academy of Science (2006) defines science as:

> a systematic method of continuing investigation, based on observation, scientific hypothesis testing, measurement, experimentation, and theory building, which leads to explanations of natural phenomena, processes, or objects, that are open to further testing, revision, and falsification, and while not 'believed in' through faith are accepted or rejected on the basis of scientific evidence (p.130)

The Academy also states the importance of science as being more than a collection of data but rather "a tool used objectively to explain the ever-changing, natural universe in which we live. Science provides an objective, systematic, self-correcting way to determine when to accept or reject a theory or concept regarding the natural universe" (p.133-4).

Rush Holt Jr., physicist, educator, policy-maker and leader of American Association for the Advancement of Science advocates thinking like a scientist to help people become better problem solvers even for those not aspiring to be a scientist. Scientific thinkers are able to separate ideology from evidence, making them more aware of mental blind spots, such as prioritizing short-term benefits when evaluating possible courses of action (Wren, 2015). Craig R. Barrett, Chairman of the Intel Corporation, sponsor of the Intel Science Fair for Society for Science & the Public (SSP), believes energy will be the Sputnik of the 21st century, igniting the need for a more scientifically literate society to solve the challenges of climate change and the rising demand for fuel (Cavanagh, 2008). If one subscribes to this premise then it is reasonable to surmise that teaching the new scientific standards by preparing students for science fair is an effective way to reach the goal of attaining a scientifically literate society.

Science fair, which has been a pillar in public education for decades, began in 1942 as the first Science Talent Search sponsored by Westinghouse Electric Corporation through a non-profit organization called Science Service, the forerunner of today's Society for Science & the Public (SSP), a tax-exempt, non-profit organization dedicated to the promotion of scientific research and education since 1921. The title changed from Science Talent Search to National Science Fair in 1950 and became international in 1958 when Japan, Canada, and Germany joined the competition. This partnership with Westinghouse endured for 57 years. Intel Corporation sponsored the science fair from 1998-2016 changing the title to the Intel International Science and Engineering Fair (Intel ISEF). In 2016 Regeneron Pharmaceuticals Inc. became the third sponsor of the Science Talent Search, renaming it for the next ten years to be known as the Regeneron International Science and Engineering Fair for high school winners of local and regional science fairs. It is currently the largest pre-college scientific research event in the world with more than 1,500 students, grades 9-12, from fifty-two nations currently competing annually in Washington D.C. In the year 2000 the SSP added grades 6-8 when the Broadcom Foundation sponsored the event known as the Broadcom MASTERS (Math, Applied Science, Technology and Engineering for Rising Stars) competition. Past participants include holders of more than 100 of the world's most coveted science and math honors including five National Medal of Science winners, three Breakthrough Prize awardees, twelve MacArthur Foundation Fellows, two Fields Medalists and eight Nobel Laureates. (SSP, 2015)

For 67 years the Ohio Academy of Science has hosted a state science fair competition in Ohio titled State Science Day. The Academy divides the state into 17 districts, each of which organize a science day for their county schools, sending winners to the annual State Science Day. Students judged “Exemplary” compete further in the Broadcom Masters or ISEF.

Participating in the science fair experience is an effective way for students to learn of their physical world in a meaningful and educationally sound way and to form questions constructed by themselves implementing the scientific method. It teaches students to think like a scientist, which can help them become better problem solvers (Ebbel, 2010; Wren, 2015). “Most would agree that the general purpose of scientific inquiry is to develop a comprehensive understanding of the world in which we live” (Haysom, 2013, p.41). The National Academy of Science (Kober, 2015), The National Science Teachers Association, (Haysom, 2013), The American Association for the Advancement of Science (Wren, 2015), and The National Research Council (NRC, 2012, p.8) all support educating students in science through inquiry, using the scientific method to problem solve, providing students with engaging opportunities to experience how science is actually done. The above all support the science fair experience. The NRC released the document ‘A Framework for K-12 Science Education’ (NRC, 2012) with the intent to be used as a guide for developing science curriculum in schools throughout the country. The suggested practices include students asking questions, developing models, planning and carrying out investigations, analyzing and interpreting data, using mathematics and computational thinking, constructing explanations, engaging in argument from evidence, and obtaining, evaluating, and communicating information. The Next Generation of Science Standards was built from this framework and is currently being adopted and used by school systems nationwide to develop science curriculum.

Science fair is a way for students to choose a topic of discovery and demonstrate their understanding of the scientific method by framing their own question and constructing their own procedures. Students undertake a problem of concern, research it, form a hypothesis on that topic, test their hypothesis and report their findings. This is best accomplished over a span of months through interdisciplinary cross-curricular instruction with science instructors guiding the scientific process, language arts teachers assisting with the research paper and verbal presentation, math teachers helping with data analysis, graph and chart construction, computer teachers assisting with internet usage to research their topic, and finally the art teacher to suggest techniques for the presentation board. Often a mentor from the community is paired with the student to offer his or her expertise, facilities and resources throughout the process, especially in the testing phase. This activity culminates with an annual school science fair where students display presentation boards representing their work, and discuss their project with judges from local universities and businesses. Exceptional projects are entered into regional/district fairs and those judged "Superior" progress to the State Science Day event and possibly to the National Fair (OAS, 2015).

Purpose of the Study

The topic to be researched is the decline in teacher and student participation in school, district and state science fair, as well as the value of science fair in today's science classroom. A survey will be issued to science teachers of grades seven through twelve, administrators, and school board members to determine the reason for the decline. The literature on the topic suggests possible reasons, such as alternative tools, including Robotics, Science Olympiad Science Bowl and others being used, new teachers not familiar with science fair, teachers unable to garner support, redirection of federal and state dollars to fund new innovative STEM initiatives, and unintended obstacles to the implementation of science fair. These and other reasons will be incorporated into open-ended questions to allow for additional reasons to be identified. Questions also address options to ascertain reasons for those teachers who once participated, but no longer participate in science fair, as well as determining why some teachers have never participated in science fair, and why other teachers continue to include science fair in their curriculum.

With the current focus on STEM (Science, Technology, Engineering, and Math) education, coupled with the infusion of in-depth inquiry-based and project-based learning (AAAS, 2015; NRC, 2000) in the new 2015 Next Generation Science Standards (NGSS, 2015), one would expect to see more teachers incorporate student science projects into their curriculum, resulting in a rise in the number of science fair entries. However, instead of increased participation, just the opposite has occurred. Science fair entries have continuously, for the past twenty years, been on the decline in the Lake to River District 15 Science Day, hosted by Youngstown State University. The study will serve to identify the reasons for the decline, whether District 15 is an anomaly in dwindling participation, and to determine the value of science fair in teaching today's current science standards.

Research Questions

The research questions, one through five, for this study are aimed at gauging the subjects' perspective on and determining the reasons for the decline in science fair participation.

1. What are the qualitative and quantitative characteristics of respondents with regard to licensure, current responsibility, county, district type, and years in current position?
2. What are the science fair participation rates per district type, county, grade level, and years in education?
3. What factors are identified as barriers or obstacles that have led to the decline of science fair by preventing educators from participating in science fair?
4. What is the perceived value of science fair with regard to Ohio Science Standards, OAS Science Fair Standards, different science fair models, and alternative STEM competitions and/or activities?
5. What measures are perceived as important to the effective implementation of science fair?

Significance of the Study

Many professional educators value science fair (NSTA, 2011) in its ability to excite students about the process of science and involve them in doing science, rather than merely reading about science. "Ideally, students should be given the chance to do real research – to experience framing a question, deciding what kind of evidence is relevant and figuring out how to collect it" (Dean, 2007, para.15).

Others see the linking of students with scientists as a motivator to pursue science careers and include this process in their science fair (Ebbel, 2010; Rodia, 2004). Business people in the community, education majors, science students and professors at the local university all can serve as motivators who link students with the excitement of science.

Still others, such as the school systems in Albuquerque, New Mexico, and Los Angeles, California, view the science fair experience to be so valuable that their school districts create a facilitator/consultant of science fair (Dowden, 2012; Menicucci, 2002).

Fearing that this time consuming activity would be omitted from a teacher's already overburdened load, the facilitator assists teachers with the implementation and resources necessary through a Science Fair Volunteer Support Committee.

The National Science Teachers Association (NSTA) deems science fair so valuable that presentations accompany annual conventions to assist educators with the implementation of science fairs in their classrooms. Books and pamphlets are designed to assist teachers to help make students responsible for their own learning and introduce and prepare them for science fair success (Haysom, 2013).

Hosting a science fair may serve as an effective tool to identify potential STEM students. Students who excel in the science fair competition further their experience by competing in regional fairs, followed by state competition, where they are recognized and offered scholarships by state universities (NSTA, 2011). Without this avenue to display their talent in science, they lessen their chances of obtaining a scholarship to pursue a science career.

Lastly, and perhaps most importantly, completing a science fair project serves as an effective tool to meet both National and the 2010 Ohio Learning Standards in Science (OAS, 2015). A vital component of those standards is to adopt an inquiry-based approach to implementation (Drayton & Falk, 2002).

Accomplishing a science fair project has merit outside of the science curriculum as well. The task instills problem solving, planning, collaboration, organization, analytical reasoning, communication skills, responsibility, independence, and ownership, all emphasized in project-based learning (Bell, 2010; Davis, Hartoonian, VanScotter, & White, 2012). The aforementioned skill set is critical for an informed citizenry in any democratic republic, which is the primary goal of public education (Camins, 2013; McClung, 2013). These skills referred to as 21st century skills in Table 1, also include synthesizing and evaluating information from multiple sources identified in the Common Core Literacy Standards and embodied in the process of science fair (NRC, 2010; NSTA, 2009; p.21, 2009). Richard Allington (2001, p. 7), president of the International Reading Association contends that children must learn the process of searching and sorting through information, to synthesize and analyze the information they encounter, which is vital to the demands placed upon the individual in this age of information

"The primary purpose of public education is to prepare students to participate effectively as citizens in our constitutional democracy" (McClung, 2013, p. 38). Learning the components of government and how it works is only part of the civic standards; other knowledge and skills are necessary for an informed citizenry. Justice Leland DeGrasse interpreted a civic standard in *Campaign for Fiscal Equity v. State of New York*, and identified the knowledge and skills that voters and jurors need for productive citizenship to be the intellectual tools to evaluate complex issues, such as campaign finance reform, tax policy, and global warming. Jurors may be called upon to decide complex matters that require the verbal, reasoning, math, science, and socialization skills that should be imparted by public schools. Jurors today must determine questions of fact concerning DNA evidence, statistical analyses, and convoluted financial fraud, to name only three topics (McClung, 2013).

Completing a science fair project teaches all of the 21st century skills listed in Table 1, including those identified by Justice Leland DeGrasse in the preceding paragraph.

Table 1. 21st Century Skills divided into 3 categories (Fadel & Trilling, 2009).

Learning & Innovation Skills	Digital Literacy Skills	Career & Life Skills
Critical thinking & Problem-solving	Information literacy	Flexibility & adaptability
Communication & Collaboration	Media literacy	Initiative & self-direction
Creativity & innovation	Information & Communication technologies literacy (ITC)	Social & cross cultural interaction
		Productivity & accountability
		Leadership & responsibility

Science, once standing as an independent discipline, is now partnered with technology, engineering and mathematics to form what is commonly referred to as STEM education. STEM initiatives, such as Title VI (America Competes Act, 2007 & 2011), SB 311 (The Ohio Core Curriculum 2007), and U.S. Department of Education Race to the Top initiatives, all recognize and focus on the need to improve science education. STEM has moved science to the educational forefront, with the federal government spending in excess of three billion dollars annually to fund STEM Programs. Title VI (2007) supplies $840 million for teacher training and recruiting, grants for special projects, and STEM Schools, while in Ohio, the Ohio Core Curriculum increases graduation requirements and mandates standards to include inquiry-based instruction in the science classes.

The push for STEM may be well intentioned, but does not address the conditions in the classroom. How do we motivate our students about science when instructional time is diminished, budgets are slashed, computers are inaccessible, class sizes are too large to accommodate inquiry-based learning, and elementary teachers often don't have strong science backgrounds (Jorgenson & Vanosdall, 2002; Robelen, 2013)? The National Science Teacher's Association asked science teachers if they agreed with media reports that the perception of science fairs has changed and the events are becoming more popular. More than 64% disagreed, even though 75% reported hosting a science fair for that school year (2011-2012). The reasons they cited for science fairs not growing more prevalent were:

> insufficient student access to materials, disparities in parental support, and lack of support from students and administrators-including one principal who required new science teachers to not support a science fair. However, many still value science fairs as opportunities for students to explore new ideas, apply and develop new skills, and demonstrate their learning (NSTA, 2011, p. 17-18).

The Department of Education (DOE) offered competitive monies, known as Race to the Top Grants in 2008, for "new science innovative programs" to bolster science initiatives. Replacing science fair with an innovative program might secure much needed funding through Race to the Top, especially when schools are operating with fewer state dollars. Funding levels for public education according to the Ohio Department of Education (Appendix F) show $9.4 billion allocated by the state in 2009 with reductions to 8.8 billion in 2013 and a rise to 9.9 in 2015. What is not shown is the drain of almost one billion dollars annually diverted from public to charter schools (ODE, 2015; Urycki, 2015). Charter schools in Ohio receive more dollars per student than do public schools, resulting in loss of money from the public school every time students transfer to a charter school. This drain in economic resources may be a reason for public schools willing to accept federal dollars and grants for untested STEM programs in lieu of a tried and true pedagogical tool as science fair.

The emphasis on reading and math at the elementary level at the expense of science was a consequence of the NCLB Act (2001) which penalized schools for lower scores on student standardized tests (Darling-Hammond, 2004). This may also be a reason for junior high and middle schools no longer participating in science fair. By the time students are placed in middle school science classes, many lack the science skills necessary to enjoy a rich science process-oriented style of instruction, due to the lack of a strong science foundation formed in the primary years. Many middle school science teachers are playing catch-up, using valuable time to establish science fundamentals with little or no time left to plan for a science fair which is viewed as a “luxury” (NSTA, 2011, pg. 16).

Science fair is endorsed by science educators (NSTA, 2015), the Academy of Science, the National Science Foundation, and the National Research Council, as a premier tool to teach the process of inquiry through project-based instruction. At a time when science and STEM are stressed in the curriculum, and science fair is endorsed by the scientific community, it is perplexing to see science fair participation dwindling. Why is a proven tool to increase science interest among our students used less frequently than in the past? Why are teachers choosing not to implement this successful tool? This study will serve to answer these questions through data collected from teacher and administrator surveys.

Limitations and Delimitations

Data will be gathered from the Ohio Academy of Science, who hosts the State Science Day, to substantiate the decline in student entries (Appendices D and E). District 15 will comprise the sample population. Surveys will be distributed to science teachers of grades seven through twelve to determine why they no longer participate, have never participated, or continue to participate in school and district science fairs and the reasons. It is equally important to survey school administrators and school board members to determine their perception of the importance of science fair, as their support or lack of support, may well determine whether a teacher, school, or district participates.

A possible limitation of the study may be a low percentage of surveys returned. The main reasons for this may be in finding time in the classroom teacher's day to complete the survey. Some of the demands that draw on limited time are the incorporation and implementation of new state science standards, resulting in the remapping of science curriculum for each class, readying students for new state computerized testing of those standards, which will be administered twice yearly instead of annually, and finally, a new evaluation system mandated by the Ohio Revised Code (ORC 3319.11, 3319.12) requiring teachers to prepare pre-tests and post tests for each class as well as develop student-learning objectives, all to be phased in by 2014-15 with no added preparation time for teachers.

The delimitation placed on the survey is the intended population to which it is addressed. The surveys will be sent to classroom science teachers, principals, superintendents and school board members, within the four counties.

Definition of Terms, Acronyms & Organizations

Many terms, concepts, acronyms and organizations will be referenced throughout this study. A brief explanation of each is provided below.

American Association for the Advancement of Science (AAAS) is an "international non-profit organization dedicated to advancing science for the benefit of all people" (AAAS, 2015 para.1) It is also the largest scientific organization in the world and publishes the magazine 'Science'. To advance science and science education AAAS helps to bridge gaps among scientists, policy-makers and the public. It is the authoritative source for information on the latest developments in science. One of its main goals is to foster education in science and technology for everyone. A current primary education initiative entitled Project 2061 strives to help all Americans become literate in science, mathematics and technology before Halley's Comet returns in 2061 (AAAS, 2015).

The National Association of the Academies of Science (NAAS) is the national organization for the state science academies and it is an affiliate member of AAAS. One of its roles is to organize the American Junior Academy of Science (AJAS) to promote statewide scientific research competitions, one of which is science fair (NAAS, 2015).

The Ohio Academy of Science (OAS) & other state Academy of Science organizations is referenced numerous times in the 2009 Overview of the newly revised science standards, (ODE, 2009) as well as cited for its definition of science. It is the National and State Academies that promote the use of science fair, encourage teachers to engage in the process, and invite students to compete annually in school, district, and State Science Days. The organization's mission in each state is similar so all science fair participants follow the same guidelines enabling them to compete nationally.

The American Junior Academy of Science (AJAS) is a program of the National Association of the Academies of Science (NAAS). It is the only national honor society recognizing America's premier high school students for outstanding scientific research. Its mission is to introduce, encourage, and accelerate pre-college students into the professional world of science, technology, engineering and mathematics (NAAS, 2015).

National Research Council (NRC) was established in 1918 by the Academy of Sciences, by executive order 2859 of President Woodrow Wilson. It is the principal operating agency for the National Academy of Sciences, Engineering, & Medicine. Its purpose is to serve the national interest of the country by furnishing scientific and technical advice to governmental and other organizations which influence policies and actions that have the power to improve the lives of people in the U.S. and around the world (NRC, 2015, para.1).

National Science Foundation (NSF) is an independent federal agency created by Congress in 1950 "to promote the progress of science; to advance the national health, prosperity, and welfare; to secure the national defense…" With an annual budget of $7.3 billion (FY 2015), it is the funding source for approximately twenty-four percent of all federally supported basic research conducted by America's colleges and universities. In many fields such as mathematics, computer science and the social sciences, NSF is the major source of federal backing (NSF, 2015, para.1).

Science, Technology, Engineering, & Mathematics (STEM) is an acronym widely used today, coined by Judith Ramaley, the former Director of the National Science Foundation. There is no universally agreed-upon definition of STEM. Experts generally do agree, however, that STEM workers use their knowledge of science, technology, engineering, or math to try to understand how the world works and to solve problems. Their work often involves the use of computers and other tools (Vilorio, 2014). STEM education is an interdisciplinary approach to learning, coupling real-world lessons as students apply science, technology, engineering and mathematics, while making connections between school and the world outside of the classroom (Gerlach, 2012).

Next Generation of Science Standards (NGSS) are the new science standards developed by the National Research Council (NRC), the National Science Teachers Association (NSTA), the American Association for the Advancement of Science (AAAS), and Achieve to prepare students for college and careers. A Framework for K-12 Science Education was composed by 18 science and education experts enlisted by the NRC. Once the framework was developed, Achieve led the development of the standards collaboratively with states and other stakeholders in science, science education, higher education, and industry (NGSS, 2015).

National Science Teachers Association (NSTA) is the Arlington, Virginia-based National Science Teachers Association (NSTA), the largest professional organization in the world promoting excellence and innovation in science teaching and learning for all. NSTA's current membership includes more than 60,000 science teachers, science supervisors, administrators, scientists, business and industry representatives, and others involved in science education (NSTA, 2015).

National Academy of Sciences (NAS) is a private, non-profit organization of the country's leading researchers. It recognizes and promotes outstanding science through elected membership, and publication in its journal, PNAS (Proceedings of the National Academy of Sciences of the United States of America). Through the National Research Council, the NAS provides objective, science-based advice on critical issues affecting the nation (NAAS, 2015).

Project-Based Learning (PBL) is a learner-centered instructional approach to problem solving. Learners create a thought-provoking question to be solved, making learning meaningful for the student. With the teacher as the facilitator it becomes the learner's responsibility to acquire information. Students learn both thinking strategies and domain knowledge (Larmer & Mergendoller, 2010; Savery, 2006).

Inquiry-Based learning is a learner-centered instructional approach, focused on questioning and problem-solving that starts by posing questions, problems or scenarios—rather than simply presenting established facts or portraying a smooth path to knowledge. It encourages a hands-on approach to learning where the teacher is both facilitator and provider of information (Savery, 2006). A learner-centered approach places students at the center of classroom organization and respects their learning needs, strategies and styles. Students often work on tasks and projects in small groups. This type of learning meets the diverse needs of students. Inquiry-based learning and project-based learning are learner-center approaches to teaching (Altan & Trombly, 2001; Brown, 2003; McCombs & Whisler, 1997).

STEM Academies are specialized public schools tailored to students with talents in those subjects. North Carolina, in 2003 launched an $11 million dollar grant from the Bill & Melinda Gates Foundation to fund 86 STEM schools in the North Carolina New Schools Project. Virginia launched six academies with a focus on both career and technical education in the STEM subjects. The National Consortium for Specialized Secondary Schools of Mathematics, Science and Technology was founded in 1988 with 15 member institutions enrolled; it has more than 100 today, serving 37,000 students nationwide (Cavanagh 2008). The number of specialized STEM schools and academies for the select few is increasing, while public school dollars directed to science classrooms for the many are shrinking. Teaching the standards with a science fair pedagogy would afford all students the opportunity to learn the process of science enabling them to solve everyday problems while strengthening the science literacy for the majority of citizens.

Overview of the Study

Inquiry-based learning and project-based learning are grounded in the philosophies of John Dewey and Paulo Freire and are promoted by today's highly distinguished and influential science education authorities. These learner-centered approaches, which place the teacher in the role of facilitator, empower learners to conduct research, integrate theory and practice, and apply knowledge and skills to develop a viable solution to a problem (Savery, 2006, p. 5). "Children who have been provoked to reach beyond themselves, to wonder, to imagine, to pose their own questions are the ones most likely to learn to learn" (Greene, 1988, p. 14).

These project-based education fundamentals were written into the 2010 Ohio Learning Standards in Science and the Next Generation of Science Standards and embody the process of science fair. Science fair once prevalent in all Ohio districts, is in a downward spiral. The current trend is for states to fund STEM academies and programs emphasizing STEM careers, which improve student performance for the few, but according to the National Governor's Association, has fallen short in developing critical 21st-century skills in the general student population. Twenty-first century skills, as defined by Ravitz et al., is identified as critical thinking, collaboration, communication, creativity and innovation, self-direction, global and local connections, and using technology as a tool for learning (Fadel &Trilling, 2009; Ravitz, English, & Mergendollar, 2011, p. 3). This focus on STEM academies appears to shift the support from science fair in the classroom for all, to STEM programs and activities for a select few.

The coming chapters will address the dwindling participation in local and state science fairs and the reasons teachers and students are electing not to incorporate this tool into the science curriculum. The factors that have led to the decline of teacher and student participation in school, regional, and state science fair competitions in Ohio will be explored through research and surveys.

CHAPTER II

LITERATURE REVIEW

Introduction

It is necessary to examine the history of science education, how it evolved into STEM education, and the role science fair has played, to realize the impact and importance of this study about science fair and its lessened presence in today's science curriculum. Understanding the value of using science fair as a tool to teach the science standards necessitates the exploration and comparison of state, national and science fair standards. STEM programs that have been added to schools and districts in lieu of science fair will be compared and examined for their worth.

The History of Science Education

Across the nation, pre-1993, the emphasis in science education had been on quantity of information presented to students, rather than the quality of understanding the process of science (Rutherford & Ahlgren, 1990). Textbooks were used in the science classroom to present information, focusing on memorizing science facts. The emphasis was changed with the release of 'Science for All Americans and Benchmarks for Science Literacy' in 1993, developed by the American Association for the Advancement of Science (AAAS) and the 1996 National Science Education Standards by the National Research Council (NRC). The new standards reflected more inquiry-based learning of science with less emphasis on factual information. The NRC has become the most important influence in reshaping K-12 science instruction in the United Stated in recent years. "Inquiry into authentic questions generated from student experience is the central strategy for teaching science." (National Science

Education Standards (NSES, p. 31). The key words, “student experience” pushed forward hands-on learning versus memorization of facts.

The historical evolution of science education points to seminal events that spurred renewed efforts in science education in our public schools. The 1950s saw the birth of the ‘race to space’ with the launching of Sputnik by the then U.S.S.R. This highlighted our nation’s need for a space program and at the same time in history began the birth of the science fair competition. Under President Eisenhower, in 1958, The National Aeronautics & Space Act (Public Law 85D568) was passed creating the National Aeronautics & Space Administration (NASA). President John F. Kennedy challenged the nation in 1961 to “claim a leadership role in space and land a man on the moon before the end of the decade” (John F. Kennedy Library, 2015). Science teachers across the nation tuned their classrooms into NASA’s Mercury Missions, Apollo Missions, Landings on the Moon, and the space shuttles while implementing more hands-on science (Dean, 2007). With no mandate from Congress the public school systems addressed the challenge and elevated the importance of a strong science curriculum. The attitude, post-Sputnik, was that “having science education for everybody was a part of having a healthy democracy,” said George Hein, professor emeritus of education at Lesley University (Cavanagh, 2007).

Whether the driving force for science education be Sputnik, or warnings such as federally commissioned panels issuing reports, education reform follows; public education once again is charged to stress science education. STEM may be the new term, but science fair teaches inquiry at a basic level through project-based learning just as it has done for decades, chosen and designed by the student, teaching 21st century skills, all of which is mandated by the new standards. Do we always have to reinvent the wheel, or is science fair the best choice for teaching science today?

The History of STEM

Science education evolved even further in 2001 when it no longer was a stand-alone discipline. Judith Ramaley, Director at the National Science Foundation (NSF), reordered the acronym SMET to form the term commonly referred to as STEM (Science, Technology, Engineering and Mathematics). There have since been numerous STEM initiatives to promote science education, such as The America Competes Act, and Title VI, (2007) which provided grants for institutions of higher education to develop and implement STEM courses integrated with teacher education leading to a STEM degree. Unfortunately Congress elected not to include funding for the program in the 2008 budget. The Ohio STEM initiative, HB119, in 2007 established STEM schools and programs of excellence within the state. A $12 million dollar grant from the Bill and Melinda Gates Foundation launched the Ohio STEM Learning network, a new public-private partnership with five regionally located schools focused on STEM skills (NSTA, 2008).

In 2008, then-Senator Barack Obama garnered support and passed a bill for the Creation of the STEM Research Repository and the new office and position of assistant secretary for STEM Education in the Department of Education (DOE). When elected president, the Obama administration implemented U.S. DOE Race to the Top initiatives, which offered schools competitive grant monies for innovative STEM programs. Such programs like the one in Clarksville-Montgomery County, Tennessee school system used Race to the Top monies to pilot its externship program, connecting teachers with local businesses for on-site learning experiences through job shadowing. The program also integrated math and science classes using project-based learning, in which students are exposed to the science and math standards by identifying and resolving real-world problems that require the use of those skills. Local business professionals visit classrooms to help students solve problems. The superintendent who spearheaded the project, B.J. Worthington, was a former science classroom teacher who saw the need to bolster the district's STEM focus (Heitin, 2014, p. S27).

In 2009 President Obama kicked off his "Educate to Innovate" campaign. The White House would now host an annual science fair to showcase the winners of national competitions in science and technology. The event is televised in classrooms and promoted through the local media with the intent that science oriented students would serve as role models.

The Congressional chartered report, 'Rising Above the Gathering Storm' (National Academies), issued in 2005, was much like 'A Nation At Risk' (National Commission of Excellence in Education), of 1983, which warned that the United States was engulfed in a rising tide of mediocrity and student apathy toward math and science, as well as the country's lack of federal investment in cutting-edge scientific research, which cautioned of a serious economic and national-security risk to the country (Cavanagh, 2008, p. 9; Dean, 2007, para.7-8). The report ignited an urgency for improved science education and was the catalyst for the 2001 NCLB Act that was implemented with new standards to teach science through inquiry and many recent STEM initiatives. The Next Generation of Science Standards, the model used for today's science standards in public schools followed.

The formation of Regional STEM hubs is becoming commonplace across the country. They comprise a coalition of K-12 schools, universities, businesses, and community organizations, such as non-profits and museums, working together to improve education in the STEM fields, connecting classroom students with real life experiences with the goal of boosting the technical workforce. The Bill and Melinda Gates Foundation, Battelle, and the AT & T Foundation are supporting a national movement for a STEM Learning Network to create and institute innovative and sustainable STEM schools, policies programs, platforms, and partnerships to improve the college and career readiness of all students. This network helps connect Long Island with other New York STEM hubs as well as other states (Cradle of Aviation Museum, 2015). The Governor of Oregon infused $2.8 million dollars in grants to promote six such hubs across his state (Heitin, 2014, p. 20). Northeast Florida launched a STEM hub to encourage a pipeline of talent for the local economy (Jones, 2015).

The Math and Science Partnership Program of 2015 was federally funded for $202.7 million, a $50 million increase from the previous year; $25 million of which is earmarked for competitive grants to support STEM networks. Three billion dollars was allocated for STEM education programs across thirteen federal agencies in 2015, up 3.6 percent from the previous year (NSTA, 2015).

State and federal STEM legislation increased simultaneously with the revision of the Ohio Education Science Standards in 2005, which emphasized inquiry-based instruction. The New Ohio Learning Standards in Science (2010) contains more in-depth inquiry based, project-based, problem-solving instruction than the preceding standards. They were formulated from the National Science Standards developed by the Academy of Science that promotes science fair and hosts the annual State Science Day. With each revision, the standards incorporate more science fair standards, standards necessary to complete a science fair project.

A more recent revision of the science standards by the National Research Council (NRC) was completed in 2012 titled 'A Framework for K-12 Science Education', which outlines a broad set of expectations for students in science and engineering. It proposes a new approach to K-12 science education that will capture students' interest and provide them with the necessary foundational knowledge for basic proficiency and continuing study in science. The Framework states, "throughout grades K-12, students should have the opportunity to carry out scientific investigation and engineering, designing projects related to the disciplinary core ideas" (A Framework for Science Education, p. 9). This Framework was a guide for developing the Next Generation of Science Standards (NGSS) that have been adopted by twelve states and the District of Columbia as of June 2015 (Appendix A). Ohio is one of the 26 lead states that provided leadership in writing the NGSS, but has not adopted them as of June 2015.

"The 2010 Ohio Learning Standards in Science serve as a basis for what all students should and be able to do in order to become scientifically literate citizens equipped with knowledge and skills for the 21st century workforce and higher education " (ODE, 2011, p. 9). These standards place a heavier emphasis on student participation, with the inclusion of problem-based learning to teach the scientific method of inquiry, than did the previous standards adopted in 2002. The standards adopted in 2011 with full implementation in 2014-15, are based on the Next Generation Science Standards, from the Science Framework, which emphasize essential practices that have a significant influence on inquiry and argumentation (NCR, 2012).

Comparing NGSS & State Standards with the Science Fair Process

A Framework for K-12 Science Education (NRC, 2012) which is the foundation of the Next Generation Science Standards (NGSS, 2015) has this to say about student independence:

> Students should have opportunities to plan and carry out several different kinds of investigations during their K-12 years. At all levels, they should engage in investigations that range from those structured by the teacher-in order to expose an issue or question that they would be unlikely to explore on their own (e.g., measuring specific properties of materials)-to those that emerge from the students' own questions. As they become more sophisticated, students also should have opportunities not only to identify questions to be researched but also to decide what data are to be gathered, what variables should be controlled, what tools or instruments are needed to gather and record data in an appropriate format, and eventually to consider how to incorporate measurement error in analyzing data (p.61).

All the objectives expressed in the Framework for K-12 Science Education can be accomplished through the science fair curriculum.

The Next Generation Science Standards are the national model for states to use when formulating their standards, or they can be adopted in their entirety. Students in grades five through eight, using the NGSS, must master the following processes: students must learn to ask questions for science and define problems for engineering, they are to develop and use models and plan and carry out investigations, analyze and interpret data, use mathematical and computational thinking, construct explanations and design solutions, engage in argument from evidence and obtain, and evaluate and communicate information (Appendix A).

The 2010 Ohio Learning Standards in Science for grades five through eight require students to use the scientific processes, with appropriate laboratory safety techniques, to construct their knowledge and understanding in all science content areas. They are to be able to identify questions that can be answered through scientific investigations, design and conduct a scientific investigation, use appropriate mathematics tools and techniques to gather data and information, analyze and interpret data, develop descriptions, models, explanations and predications, and communicate scientific procedures and explanations (Appendix B).

The Standards set forth by the Ohio Academy of Science (OAS) must be met in order to submit a science fair project in the regional/district and State Science Days. They require students to define a problem or ask a question, complete background research on the topic, construct a hypothesis, design a test with an experiment, compile data using a log book, write up information in a research paper, and communicate the results (Appendix C).

All three sets of standards, NGSS, Ohio DOE, and the OAS Science Fair Process (Appendices A, B, & C) share a plethora of commonalities. They all expect students to follow the process of scientific inquiry by defining and solving problems through a student focused project-based curriculum, such as used in the process of completing a science fair project. This differs greatly from the cookbook approaches to teaching inquiry with pre-fabricated purchased kits containing ingredients, equipment, instructions and results, all known in advance (Dean, 2007; Windschitl, 2009). The pre-fabricated lesson may fit in a 40 or 50 minute class period, but it does not promote science literacy, which requires scientific investigations with observations and evidence, alternative explanations, progressions of goals and reasoning (Ahlgren, & Wheeler, 2002). Science labs should not be stand alone add-ons to the curriculum, but should be an integral part of it (Cavanagh, 2007). Completing a science fair project is a work in progress, a coordinated set of activities, deeply integrated into the curriculum, rather than disconnected, separate labs that students are often unable to connect to science content (Drayton, 2002; Robelen, 2010; Windschitl, 2009).

Collaboration, innovation, critical thinking, analysis, evaluation, and communication are components shared in all three documents. Teachers are currently searching to find curricula compatible with the new science standards. Organizations such as Achieve have begun producing for-profit materials aligned to the new standards (AAAS, 2015). The process used to complete a science fair project teaches the new national and state standards. The completion of a science fair project involves the student employing the scientific method to solve a problem of choice, while meeting all the goals common to all three sets of standards. Science fair is project-based learning engaging learners in higher-order thinking processes, such as analysis and synthesis, in order to complete their project. Learner-centered inquiry, such as project-based learning is the primary vehicle for students to develop meaningful understanding (Dunkhase, 2003). Completing a science fair project includes both relevance and learner-centered inquiry, as students choose their own subject matter and solve their problem using the scientific method. In this way, it is the process of science that produces learning. Students who complete science projects and participate in science fairs are the scientists of tomorrow (Ebbel, 2010). Scientific inquiry is an extremely important tool used for completing science fair projects, as well as everyday life activities. Teaching, interviewing, fixing a car, cooking, all require the process of scientific inquiry; they are all problem-based. One asks the question, searches for the answer, and makes adjustments and improvements, which are all part of the scientific process (Harwood, Phillipson, & Reiff, 2005). It is a lifelong skill needed to succeed in everyday experiences.

Preparing students with the skills needed for 21st century jobs, included in the new standards, such as writing and speaking well, analyzing complex problems, finding and synthesizing information from many sources for creative problem solving, are skills needed for all citizens (Tucker, Darling-Hammond, & Jackson, 2013) and learned from the science fair experience. Participating in science fair not only teaches students the required science standards and creates critically thinking citizens for our democratic republic, (Camins, 2013) but it also excites some students to pursue STEM careers (Ebbel, 2010) which can ease the shortage of scientists and STEM-related jobs ("Joining the", 2014). Data from the U.S. Bureau of Labor Statistics show that employment in STEM occupations is projected to grow to more than nine million between 2012 and 2022, an increase of about one million jobs over 2012 employment levels. The STEM workforce accounts for more than 50% of U.S. economic growth (Vilorio, 2014).

Scientist Erika Ebbel, from Massachusetts Institute of Technology credits her experiences in science fair throughout middle and high school in California, with her success and assists local schools in orchestrating their science fairs. Dr. Shirley Malcom, an ecologist, director of education and human resources at the American Association for the Advancement of Science (AAAS) credits the excitement of Sputnik and her science teacher who engaged her class in doing science with her career accomplishments (Dean, 2007). The Westinghouse Talent Search participants frequently pursued careers in the sciences (Huler, 1991), and according to Olsen (1985), working in the sciences indicated that science fair experiences had influenced their career choice. "Anecdotal evidence for 28 years at the George Washington Carver School in Philadelphia, Pennsylvania, has shown that many of the science fair participants have pursued science careers after graduation" (Fadigan & Peter, 2006, p 43). These examples demonstrate the pipeline effect from science fair participation to STEM careers.

Increased STEM funding, desperately needed in science classrooms, is earmarked for new innovative STEM programs leaving teachers to present the new rigorous science curriculum with little resources for their students (NSTA, 2013). Cash starved school districts accept grant monies targeted for innovative STEM career programs only benefitting a select few. STEM legislation, such as Ohio STEM Initiative, STEM Hubs, STEM Academies, is driven by demand from business, for a “STEM ready workforce” (O’Neil, 2015) to promote STEM careers. The focus of STEM does not hold at its center fundamental education precepts, but rather very narrowly defined career based incentives. These STEM programs, schools, or activities are not as all-encompassing as science fair, and they are geared toward the few, not the entire class or school district population. A disconnect between STEM legislation and the classroom teacher exists, with little funding targeted for the classroom teacher, who derives little or no benefit from the STEM programs. Teachers need a proven curriculum, such as science fair, to teach the science standards to all students.

The new national and state standards expose students to the process of science to be applied in all life situations. The hierarchy of learning teaches children the science fundamentals of how to learn before applying those concepts to a STEM career. Public schools provide a STEM-ready workforce when students master the science fundamentals of how to learn and solve problems, which can be taught through science fair. Graduates can then be taught specific skills needed on the job site, rather than in a STEM science school or academy. Legislators who are not familiar with this pedagogy enact legislation providing funding for career training while underfunding basic education for all, leaving the classroom teacher with few resources to teach the new standards needed to yield a STEM-ready society. Education leadership must come to the realization that STEM career is not synonomous with STEM education.

While strides were being made to improve science education through reform, it became apparent that science at the elementary level was not progressing. The No Child Left Behind Act of 2001 (NCLB), a revision of the Elementary and Secondary Educational Act, stressed accountability while heavily emphasizing reading and math. Data compiled have shown that No Child Left Behind has negatively impacted science classes (Abrams, Pedulla, & Madaus, 2003; Brickhouse, 2006; Darling-Hammond, 2004; DeBoer, 2002; Linn, 2003; Madden, 2008; Shaver, Cuevas, Lee, & Avalos, 2007).

The Center on Education Policy in its 2007 report showed that elementary schools increased time spent in reading and/or math for NCLB Assessments, while decreasing time allotted for science. The 2012 National Survey of Science and Mathematics Education, conducted with support from the National Science Foundation, found that grades K-3 teachers spend, on average, nineteen minutes per day on science instruction and fifty-four minutes on Mathematics, compared with eighty-nine minutes for reading/language arts, according to the nationally representative survey of teachers. Math and science get a little more time in grades four through six, when the combined average is about the same as for reading. The study also found that science is not taught every day in the elementary grades (Robelen, 2013).

“STEM Education is vital to our nation’s continued growth, leadership, and development”; since the passage of the NCLB Act and its requirement of annual testing for math and reading, the same amount of investment, instructional time, and curriculum development has not gone into science, states Adam Gamoran, chairman of the NRC Committee and professor of education policy at the University of Wisconsin-Madison (Fleming, 2011, p. 4).

Alternative STEM Activities

Alternative STEM activities and competitions may be taking the place of science fair and causing the decline in participation. There are many on-line competitions by major corporations that offer enticing monetary prizes much larger than local and regional science fairs. Toshiba's 23rd Annual ExploraVision challenges teams to design technologies that could exist in twenty years for a grand prize of $10,000 in U.S. Savings Bonds. The creator of Bubble Wrap cushioning had its eighth annual Bubble Wrap Competition for Young Inventors in grades five through eight. The Sealed Air Corporation offered a grand prize of $10,000 Savings Bond and a trip to New York City. Siemens Science Research Competition since 1999 offers prizes from $1,000 to $10,000. Discovery Education 3M Young Scientist Challenge premiered in 1999 for grades five through eight. Through video, it connects students with scientists to complete their project. There are hundreds, if not thousands, of competitions for students to engage in, on-line as well as in their own communities or even their own school. Local organizations like the Trumbull County Soil and Water Conservation District offer students an Envirothon Competition for a team of students from a school to compete locally; winners can then progress to the national level. Many schools participate in Robotic and Lego Competitions, Physics events in bridge building and egg drops, or contests that test knowledge of the oceans such as the Penguin Bowl at Youngstown State University. There is a myriad of STEM-related activities for students to join. It just might be that schools have decided to engage in these activities in place of science fair.

Jennifer Ryan, an education researcher at the Harvard Graduate School of Education conducted a "broad survey of 200 press articles published between 2008 and 2013 to examine the ideas, attitudes, and potential benefits of the maker movement." (Ryan, 2015, p.18). The maker movement is the infusion of today's computer technology, 3D printers, metallurgy, conductive painting and other manufacturing tools, which are infiltrating education in America with the selling point of boosting STEM. The study warns, "very few articles reference empirical support or tease out the underlying capacities and competencies cultivated through the act of making…painting a rather superficial pedagogical picture"(p. 18). The study further states that it is the responsibility of all stakeholders to "make sure that the thinking and learning behind maker-centered learning dictate the tools, rather than the other way around" (p. 19).

There is, however, a difference between the above-mentioned competitions and science fair, where the teacher, and/or science mentor oversees the student project to ensure the student is mastering all facets of the scientific inquiry process. Without this oversight, the student will most likely not master the scientific process. Many of the competitions do not contain all components of science fair. Some require no formal research paper to accompany a student's project; others are on-line only, so students do not reap the benefit of honing their communication skills. Students electing to compete in these other activities are individual students or groups, not the entire class, and today's state science standards require all students to master these skills. The process of completing a science fair project, when guided by the classroom teacher, is the complete package for teaching all of the next generation science standards to all students, not just a select few.

CHAPTER III

METHODOLOGY

Introduction

Design of Study/Organization

Using a combination of methodologies in educational research provides rich results and is deemed more valuable than applying any single method by itself (Creswell, 2003; Tashakkori & Teddlie, 2003; Thomas, 2003). The tool selected for this study to gather information about educators' experiences and value for science fair will be conducted in the form of a survey. The survey is an appropriate tool for a non-experimental, descriptive research study to gather information from a group of subjects. (Ary, Jacobs, Razavieh, & Sorensen, 2006, p. 31). It serves to collect both quantitative and qualitative data to answer the research questions to determine the reasons for the decline in science fair participation.

The subjects selected for the survey are located within four Ohio counties. These four comprise District 15 determined by The Ohio Academy of Science (OAS). District 15 participation trends are compared with the other districts in Ohio to determine whether decline is the norm or anomalous. Though interviews yield rich information, it was thought that gathering data from a large sample such as four counties would be accomplished much more efficiently with a survey; therefore the instrument chosen to test the hypothesis is a self-composed survey consisting of twenty-five questions (Appendix G). Using a survey to question educators in all four counties brings a finer focus on the problem while increasing the sample size and adding to the validity of the study.

The observed decline in District 15 science fair participation in Ohio for the past fifteen years was confirmed from data gathered from the Ohio Academy of Science. This data will be used to compare District 15 with all other districts in the state (Appendices D and E). The Ohio Academy of Science divides the state into seventeen districts, all of which host annual science fairs open to students in those districts. The students receiving “Superior” ratings at the district fair then compete at the state level in the OAS Science Day Competition in Columbus. It was decided to use District 15, hosted by Youngstown State University, as the sample population in this study because of the researcher’s involvement with the district in many capacities for twenty years, and because the decrease is the most severe of all seventeen districts.

The population studied within District 15, encompasses science educators and administrators in the four counties of Ashtabula, Columbiana, Mahoning, and Trumbull. These comprise the counties assigned by the Academy of Science to the District 15 Lake to River Science Day. The number of science fair entries between 2001 and 2015 were obtained from the Academy of Science from each of the seventeen districts. The data will be analyzed for trends in participation and compared with those from District 15.

Instrumentation/Measures

The study will attempt to determine the reasons for decline using qualitative and quantitative questions to identify reasons for the decline. Table 2 connects each survey question to the five research questions. It was constructed to assure the survey questions address the tenants of the research questions.

Table 2. Qualitative/Quantitative Correlation of Research Questions with Survey Instrument Questions

Research Question	Survey Question
1. What are the qualitative and quantitative characteristics of respondents with regard to licensure, current responsibility, county, district type, and years in current position?	#1-9, 17, 18, 20, 21, 22, 25
2. What are the science fair participation rates per district type, county, grade level, and years in education?	#2, 6, 9, 10, 11, 17
3. What factors are identified as barriers or obstacles that have led to the decline of science fair by preventing educators from participating in science fair?	#12, 14, 21, 22, 25
4. What is the perceived value of science fair with regard to Ohio Science Standards, OAS Science Fair Standards, different science fair models, and alternative STEM competitions and/or activities?	#13, 16, 19, 20,25
5. What measures are perceived as important to the effective Implementation of science fair?	#15, 23, 24, 25

A 25-question survey was constructed using the research questions in Table 2, designed to ascertain the reasons for the decline in teacher and student participation in science fair at the district level. From 2001 to 2015 District 15 Science Council and the OAS recorded a significant drop in student participation from 492 to 108 students (Appendices D and E). Years prior to 2001 have undocumented participation rates above 600 students. It was decided that data would not be used prior to 2001, because those numbers could not be validated with the OAS or District 15 Science Council due to unavailable data, yielding incomplete records.

The number of science fair entries was decreasing while state science education standards were revised to incorporate more project-based, problem-solving curricula. With the adoption of the New Ohio Learning Standards for Science, which stress inquiry and project-based instruction, a reasonable hypothesis would be that participation in science fair would increase when in fact, the opposite continues to occur in most Ohio districts. Even with the addition of grades five and six to the OAS competitions for the past five years the total participation rate has not increased.

Ascertaining the attitude of the respondents about their experiences with and their understanding of science fair requires the use of multiple-choice questions including a rating scale. “A commonly used attitude scale used in educational research is Likert scale” (Fraenkel & Wallen, 2006, p. 127). It is for this reason that a survey instrument containing qualitative and quantitative questions will be used to gather the needed data for an accurate profile of the respondents’ attitudes toward science fair.

The survey results will be analyzed using the online services of Survey Monkey to compute frequency distribution, mean and standard deviation to identify reasons for science fair decline. The mean will be computed by assigning a value for the degree for each response: one for strongly disagree, two for disagree, three for undecided, four for agree, and five for strongly agree. The value will then be multiplied by frequency of response within each category. Categories will be added and the sum divided by the total of the values. This mean will determine which category included the most responses and will be used for comparison.

Subjects/Population/Sample

School policy and procedure is beyond the classroom teacher's responsibility and is driven by the administration; therefore, principals, administrators, and school board members from the four counties that comprise OAS District 15, will be included in the survey. Science teachers in grades seven through twelve will be issued the survey even though science fair now embraces grades five through twelve. Teachers of grades five and six are intentionally excluded from the survey, since the typical elementary teacher instructs across the curriculum. Many are not easily identified as science teachers in their school, with most fifth and sixth grade teachers assigned all discipline content for their self contained class while other schools have a designated science teacher for those two grade levels.

The survey instrument will be electronically mailed to each educator through the Educational Service Center in each of the four counties (Ashtabula, Columbiana, Mahoning, & Trumbull) that participate in District 15 Science Day. Follow up surveys will be sent to non-responding participants after a two week period and then again after the following two weeks.

The procedure outlined in this chapter was submitted to and approved by the Institutional Review Board for adherence of applicable university protocol ensuring the protection of all subjects participating in this study.

CHAPTER 4

RESULTS

Introduction

The current Ohio Learning Standards in Science are project-based, contain 21st Century skills and share all of the objectives and standards as the science fair standards outlined by the Ohio Academy of Science whose main focus is to assist with district science fairs and implement the annual state science fair. With such alignment of the Ohio standards to science fair, one would expect the participation rate in science fair to remain constant or increase, however there has been a sharp decline in science fair participation. It is the purpose of this study to determine the value placed on science fair by the educational community and the reasons for the decline.

This Results chapter is organized into the following sections: description of the sample, examination of the research questions, and analysis of instrument results.

Description of the Sample

The Ohio Academy of Science (OAS) hosts an annual science fair for all students in grades five through 12, rated as superior in each of the seventeen OAS district competitions. District 15, known as Lake to River, is comprised of four northeast Ohio counties (Ashtabula, Columbiana, Mahoning, and Trumbull), which participate in the District 15 annual science fair hosted by Youngstown State University. District 15 was used as the sample because of the researcher's work and science fair experience within this district. Superintendents, principals, assistant principals, science curriculum specialists, and classroom science teachers of grades seven through 12, both public, charter, and parochial schools within the four districts were invited to participate in the on-line 25-question survey. Of the 600 invitations sent over a three-week period, 162 responded.

For the purpose of this study it was originally proposed, as stated in chapter three, that school board members would be included in the sample population. After closer consideration of school board member duties, varied backgrounds, job descriptions, and work experiences it was determined to exclude school boards from the survey to yield a more focused study, centered on the experiences of professional educators and their science curriculum perceptions and understandings.

Email addresses of superintendents, principals, curriculum specialists and science staff of grades seven through twelve were retrieved from school websites in the four Ohio counties of Ashtabula, Columbiana, Mahoning and Trumbull. Educational Service Centers assisted with addresses for schools that did not identify science staff on their webpage. The names of contacts displayed on the websites were not collected for ethical purposes in maintaining confidentiality and anonymity. Email addresses were entered into Survey Monkey for purposes of distributing the survey.

Examination of Research Questions

Table 2 in the previous chapter, titled A Qualitative/Quantitative Correlation of Research Questions with Survey Instrument Questions, lists the research questions associated with the 25-survey questions used in the instrument to determine the reasons for the decline of science fair and its perceived value by the educational community in the four county area used as the sample. These questions have been placed into five categories for analysis:

1. Profile of respondents,
2. Science fair participation rates,

3. Factors identified that have led to the decline in science fair participation,
4. Perceived value of science fair, and
5. Measures perceived as important to the effective implementation of science fair.

Data Analysis

Descriptive statistics including frequency, mean score, and percentage were used to interpret the data from the sample population. Frequency distributions and cross tabulations were prepared to report and summarize the data to form possible conclusions that determine the reasons for the decline in science fair participation.

The mean was used to consider the degree of positive or negative attitude for the questions using the Likert Scale. The mean was calculated by assigning a value for each degree, then multiplying that value to the frequency of respondents in that category. The sum of each category was added and then divided by the total number of values, resulting in the mean. The number of participants per category was most often too small to allow for significance testing with the Survey Monkey Program for the categories.

Analysis of Survey Instrument Results

Profile of Respondents

Research Question 1. What are the qualitative and quantitative characteristics of respondents with regard to licensure, current responsibility, county, district type, and years of experience**?**

The researcher emailed 600 invitations to participate in the survey with 162 returned, which yielded a response rate of 27%. The percentage of returned surveys from each county reflects the county populations with the two most populous, Mahoning and Trumbull, totaling 69% respondents and the two smallest counties, Ashtabula and Columbiana, submitting 31% (Table 3).

The qualitative and quantitative profile survey questions determined respondents professional positions, years of service, location, school district type, assignments, classroom, and science fair experience. Table 3 displays the number of respondents from many of those categories.

The category Educational Experience was further divided into years of service to compare the view of young teachers with little science fair background experience to those of veteran teachers whose professional career exposed them to science fair when it was more commonplace throughout the science curriculum. Distinguishing young and novice teachers, those with five years or less experience and veteran teachers, those with six years or more of teacher experience respectively, is a crucial identifier when analyzing perceptions, experience and opinions about science fair. The five and six year watershed was chosen because new state science standards were adopted six years ago before novice teachers were in the classroom. The veteran teacher has the perspective and experience that spans both eras, pre and post standards.

Participants designated as veteran, having six or more years experience in education comprised 92% of respondents with 8% making up novice educators with five or fewer years of experience. The novice educators elected to participate in the survey and share their opinions but are considered outliers because they are few in numbers and do not have experience with science fair in a professional perspective. One participant from this category responded that they had experience as a student competing at the state level, two stated their schools participated in the past before they were hired, six stated they never participated, and one stated that they were presently participating. One out of the ten is considered an extremely small group. The sample population is comprised of a majority of veteran educators who have been in education six or more years under current and past state standards when science fair was popular. This sample population has seen science fair implemented, and seen it decline, more so than novice educators entering the profession and can provide valuable and rich data for this study. In this, the preponderance of veteran educator perspective has a greater intrinsic value.

County

Respondents from all four counties were represented with the two largest counties, Trumbull and Mahoning having a response rate of 37% and 32% respectfully. The two smaller counties, Columbiana and Ashtabula were represented with a response rate of 17% and 14% respectively (Figure 1). A range of nine for large counties and five for small counties further confirmed the similar overall representation of respondents per county. A response rate respective of county size added validity to the results with representation from all four counties within the Ohio Academy of Science (OAS) District 15.

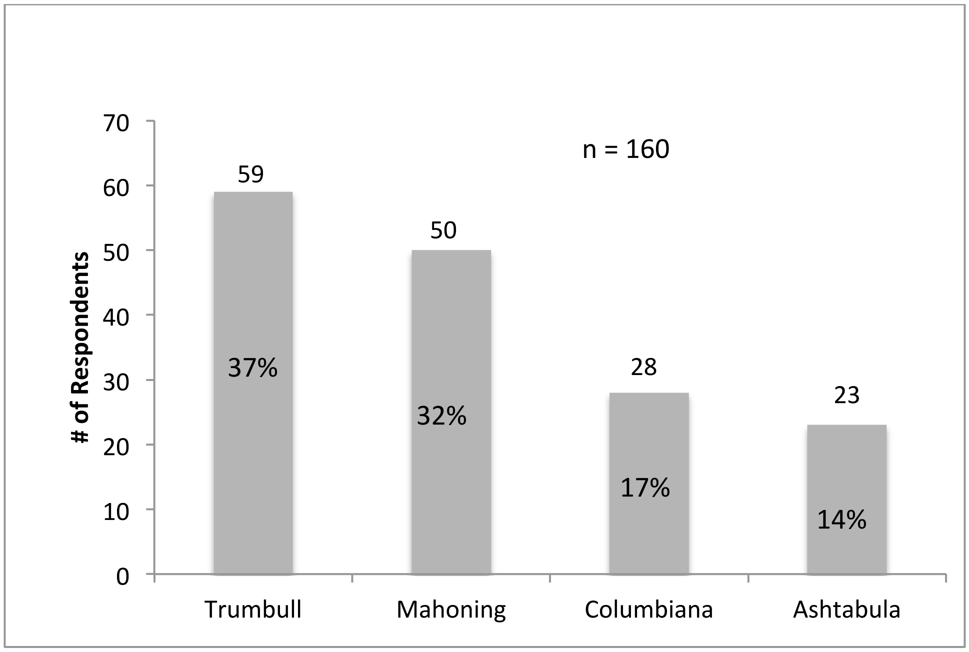

Figure 1. Respondents reporting by county.

District Type

At a rate of 98%, public schools were the largest group of respondents, followed by two parochial schools at 1.0% and one charter school at 0.6% (Figure 2). Public school staff emails were easily gathered on school and district websites. Parochial and Charter school websites were not easily attained, with most not including staff names or contact information. This lack of accessibility made it difficult to send surveys directly to science staff. In these instances, the surveys were sent to the school email address hoping that they would be routed to the science staff. Two responses were returned from parochial schools and one from a charter school, which led to an assumption that emails were not directed to science staff or science staff elected not to respond. Given the narrow sample, results linked to this category had the most uneven distribution.

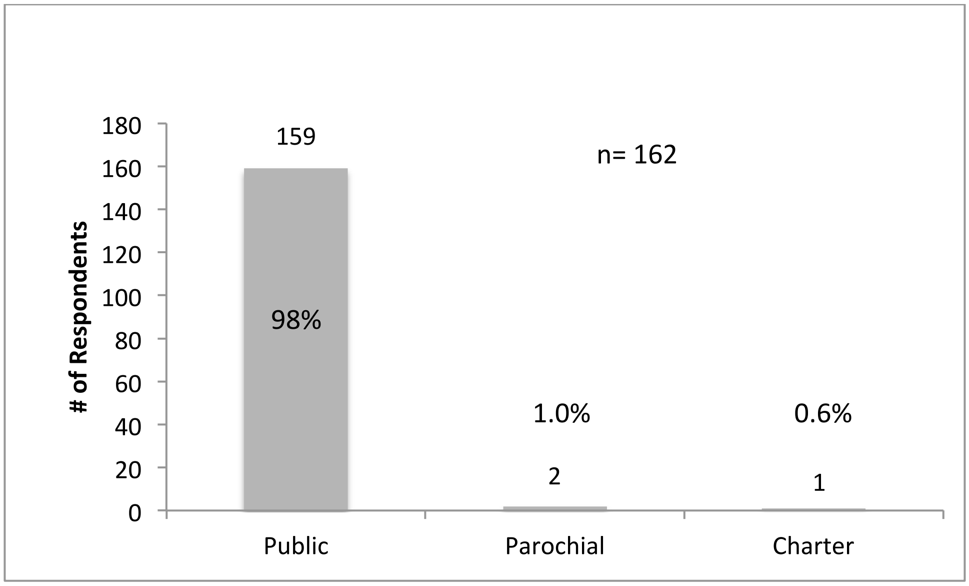

Figure 2. Respondents reporting by District Type

District Location

Each district community is reflected in the responses; rural districts 31%, urban districts 30%, small town village districts 20%, and suburban districts 19% (Figure 3). It is important to note that analyzing county data is necessary as it relates to the make-up of OAS District 15, but district data is more significant, as Ohio schools are structured by district, not county. Ashtabula County houses nine school districts, Columbiana ten, Trumbull 22, and Mahoning County 32, all under the same state science standards, using different implementation strategies and pedagogy.

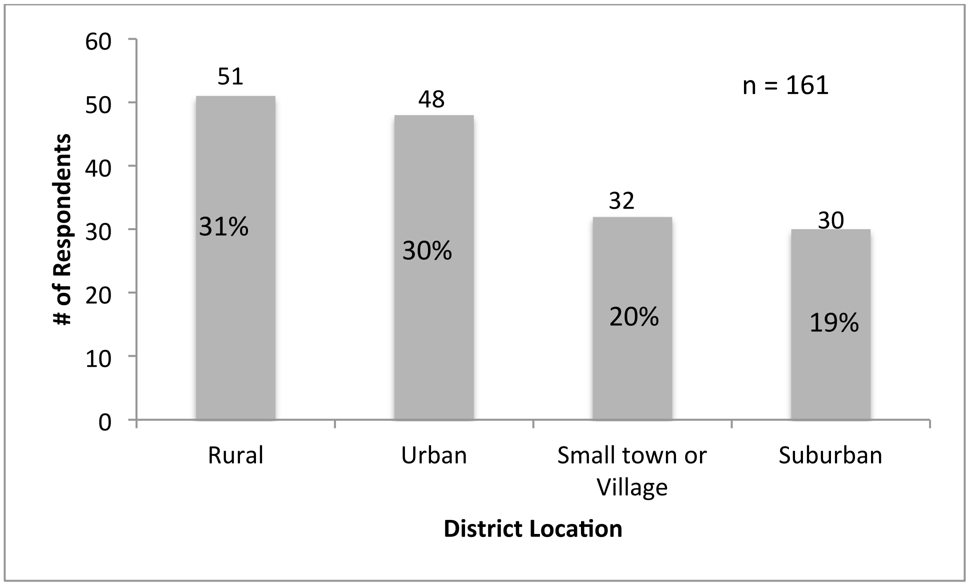

Figure 3. Type of district with respect to location for each respondent.

Educator Position

Classroom teachers, at 69% made up the largest percentage of returned surveys in the category of educator position. This was not unexpected given teachers comprise the largest group, outnumbering the administrative positions in each district. With one principal in each building housing tens or hundreds of teachers, it was foreseen that returned responses for principals and assistant principals would be the next highest at 20%, superintendents returning 6.0%, and curriculum specialists, 5.0% of the remaining respondents for this category (Figure 4).

Teachers have the most responsibility and involvement in the science fair process as the skills are taught and progress monitored in the classroom. In a true cross-curricular model, the teacher collaborates with other staff members with math teachers assisting students with graphs and charts and language arts teachers guiding the writing and research process. The principal administers logistics such as room reservations for the school science fair, scheduling events, and any budget needs.

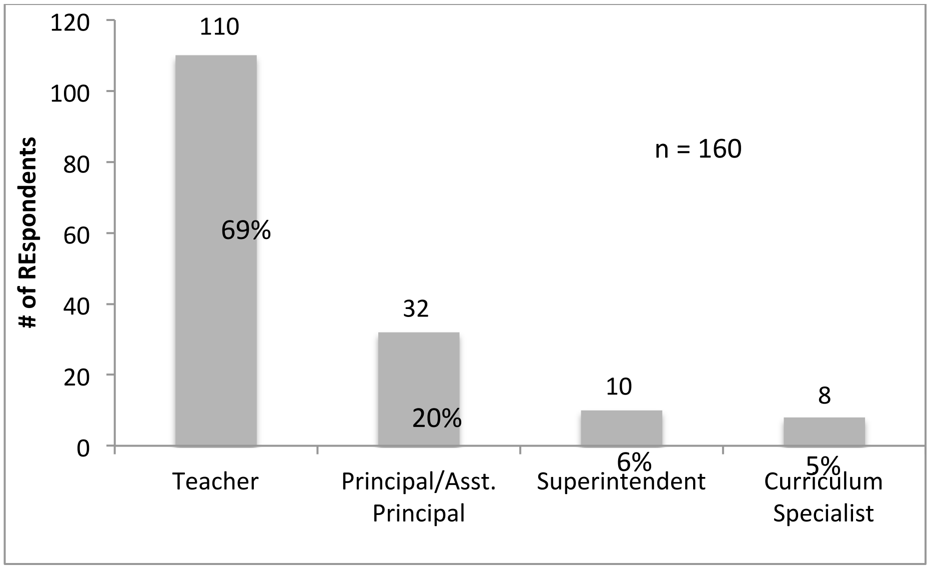

Figure 4. Educator position of each respondent.

Educational Experience

The profile question designed to ascertain years of professional experience exposed a notable separation in numbers between novice and veteran educators; novice educators being those with five or fewer years of experience and veterans with six or more years (Figures 5). Along with having a majority of licensed professionals in field, a veteran's response is inherently more valuable when assessing the perspective of science fair since their term of service as stated previously, shows they are more likely to have had some exposure to the science fair experience than novice educators. The number of novice educators responding to the survey was quite small at twelve, or 8.0%, while a much larger percentage, 92%, were veteran educators (Figure 5).

All of the teachers surveyed have been exposed to the current Ohio Science Curriculum Standards introduced in 2011, which emphasize project and problem based learning and 21st Century skills (Table 1), whereas the veteran educators' experience of past standards did not included 21st Century skills and may or may not have emphasized problem and or project based learning. Several novice educators offered their views of science fair through the lens of a student or judge if they had no experience with science fair as an educational professional. For those prominent reasons the data from both groups were compared throughout the study.

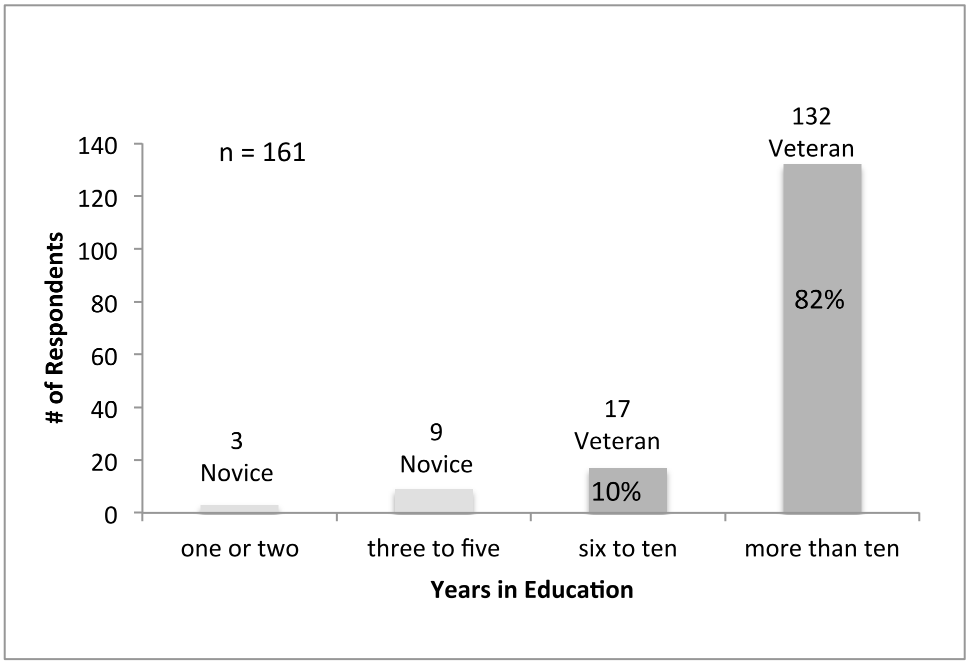

Figure 5. Educational experience for each respondent.

Grade Level

The total number of responses for grade levels was 136 with 106 teachers contributing to this response; the discrepancy was due to the multi level assignments given to several educators (Figure 6). Respondents were allowed to select more than one teaching assignment, resulting in the data reflecting grade level frequency as opposed to the number of teacher respondents. Middle school grades seven and eight were represented at 45%, and high school grades nine through twelve were responded at a rate of 55% (Figure 6). In 2010 grades five and six were added to district and state competitions to offset the decline in science fair competition. The response from grades nine through twelve was the largest population electing not to conduct science fair in recent years as observed but not documented, by the researcher at district competition. The 2017 district competition saw the lowest high school participation rate of 3.0% for the past 20 years. It was viewed that the perceptions and responses from high school educators who no longer participate would give a greater insight into the reasons for decline within that group.

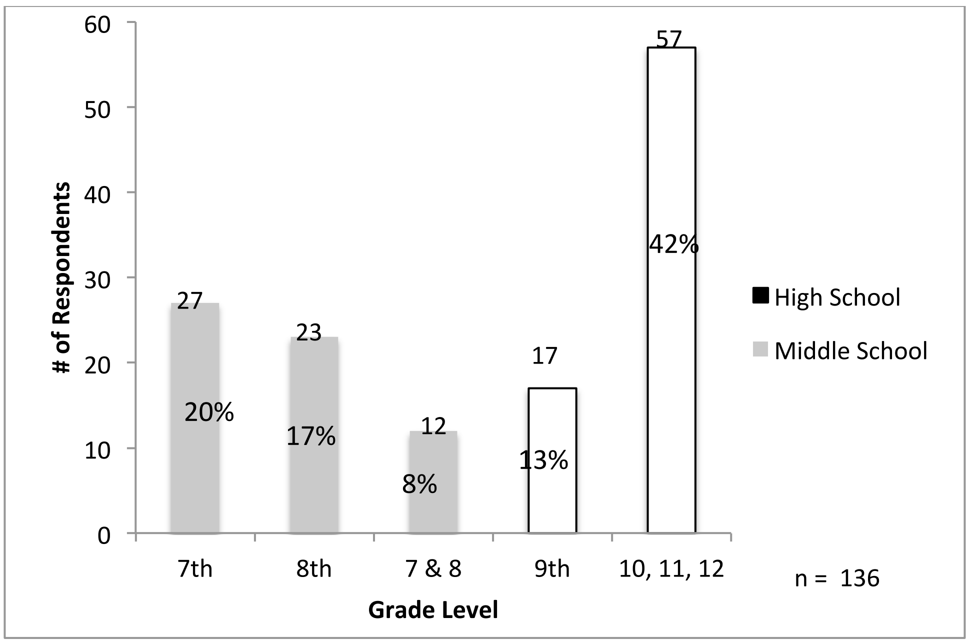

Figure 6. Grade Level Teaching Assignment of Respondents

Licensure

Respondents reported multiple teaching licenses. Of the 119 teachers that responded, 101 or 85% hold a science license that classifies them as qualified in their discipline. A majority with a science degree and license in their field of teaching lends validity to the responses regarding experience, opinion and perceptions of science fair (Table 3).

Table 3. Educator Licensure

Survey Question: What type of license do you currently have?	n	%
Science 4-9	22	19%
Secondary science	44	37%
Comprehensive or Integrated Science	35	29%
Other	18	15%
Total Respondents	119	100%

Participation

Research Question 2. What are the science fair participation rates per district type, county, grade level, and years in education?

Responses relating to schools conducting science fairs presently and in the past, and those that participated in District 15 competition, held at Youngstown State University yielded results consistent with research that showed a decline in science fair participation (Table 4).

The results showed that 10% respondents currently participate in school/district fairs, 56% participated in the past but do not currently participate, and 33% have never participated (Table 4). Additionally, in 2015-16 the decline was more severe with 109 of 162, or 67% respondents reporting they did not include science fair in the curriculum. This decline of 56% for the sample population is more severe than the 20% decline in district participation in the state of Ohio over the past 6 years and a decline of 35% over the span of the last 15 years (Appendix E).

Table 4. Respondents Participation Rates

Survey Question: How many years ago was your last school/district science fair?

Presently		15	10%	Total = 153
Past	1-2 years	25	16%	
	3-5 years	16	10%	
	6 or more years	46	30%	
Never		51	33%	

County Participation

Respondents of school districts within Mahoning County indicated a 10% current participation rate as compared with 50% previous participation, a decline of 40%. Trumbull County reported 9.0% current participation as compared with 61% prior participation, showing a 52% decline. Ashtabula County reported a 19% current participation rate, down from previous participation of 43%, yielding a 24% decline. Although a comparatively small number responded, Columbiana County showed the most decline reporting a current participation rate of 4.0% as compared with 70% prior participation rate, netting a 66% rate of decline (Table 5).

Table 5. County Participation Rates for Science Fair

Variable	Total	Present	Past			Never
			1-2yrs	3-5yrs	6 or more	
County	152					
Ashtabula	21	19%	14.3%	14.3%	14.3%	38%
		4	3	3	3	8
Columbiana	27	4.0%	37%	11%	22%	26%
		1	10	3	6	7
Mahoning		10%	8.0%	9.0%	33%	40%
	48	5	4	4	16	19
Trumbull		9.0%	14%	11%	36%	30%
	56	5	8	6	20	17

District Type Participation

Participation rate by district did not display a significant difference, with all types of districts reporting similar rates of decline. Rural districts had 61% past participation and 12% current participation, showing a decrease of 49%. Urban districts reported a 48% decline in participation, with past participation rates of 56 % and a current rate of 8.0%. Suburban district participation declined by 54%, with past and present rates at 66% and 7.0% respectively and small town villages indicated a 41% decline with past and present participation rates at 50% and 9.0% respectively. This data shows that the rate of decline does not seem to be impacted by type of district as all show a decline range of 41% to 54% (Table 6).

Table 6. District Participation Rates for Science Fair

Variable	Total	Present	Past			Never
			1-2yrs	3-5yrs	6 or more	
District	153					
Rural	48	12% 6	23% 11	13% 6	25% 12	27% 13
Urban	45	8.0% 4	13% 6	16% 7	27% 12	36% 16
Suburban	28	7.0% 2	14.5% 4	7.0% 2	39.5% 11	32% 9
Small town village	32	9.0% 3	13% 4	3.0% 1	34% 11	41% 13

Grade Level Participation

Compared to 3.0% high school participation rate, middle school grades seven and eight have a current rate of participation twice that of high school grades. Middle school participation went from 26% to 6.0% with a decline of 20% compared with high school participation rate that went from 28% to 3.0% with a decline of 25% (Figure 7).

High school participation decreased 25% in recent years with a drop from 28% to 3.0% (Figure 7). The low number of high school participants also correlates to District 15's sharp decline in high school participants (Appendix E). The state data ends in 2015; however the number of high school participants at District 15 Competition for 2016 and 2017 decreased further with participation at three, or 3.0% of all projects, the lowest it has been to this point, as reported by the District 15 Science Council which hosts the annual competition.

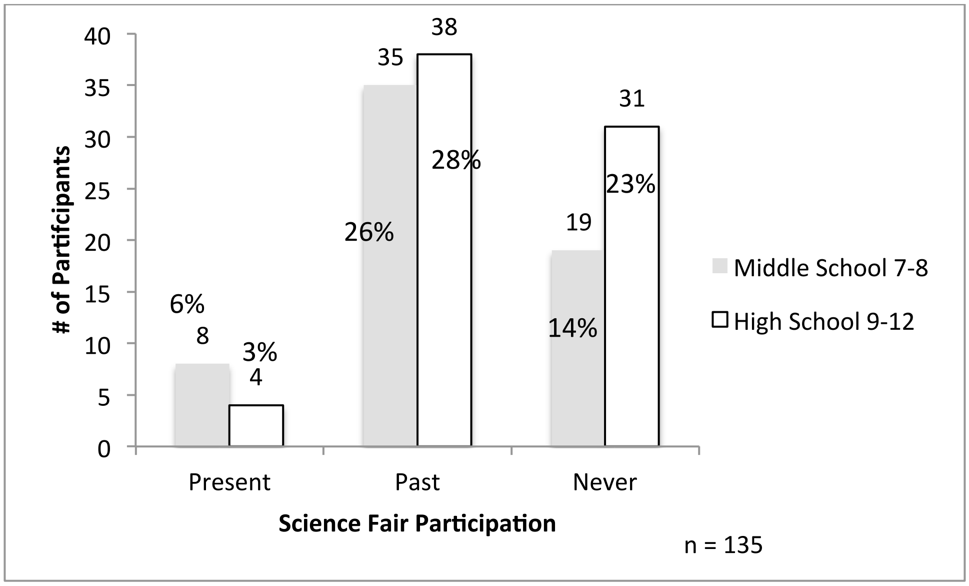

Figure 7. Science Fair Participation by Grade Level

When collecting information about past school science fairs, an additional opportunity was given to the respondents of the survey to comment on anything they felt pertinent that the survey didn't address. Notably, a high school educator's reason for not participating was, "thought that science fair was more of a middle school concept" and another responded, "this is normally done at the elementary/middle school level". An additional comment stated, "we participated in STEM Believe in Ohio last year instead of science fair". These comments should be analyzed further to form and apply a solution.

Participation by Educator Experience

The respondents never participating in science fair were composed of 30% veteran and 4.0% novice educators (Figure 8). The decrease in participation was most severe among veteran educators with past participation at 54.4% decreasing to a current rate of 9.0%, with a decline of 45.4%. The higher science fair participation rate in past years includes the veteran group. This is expected as they were educators at that time and the novice respondents were not.

In a separate question addressing participation at the District 15 level competition, the next level of competition attended by school winners, 88% (134/152) respondents reported not having participated in the district competition within the last three years. This was analyzed further to ascertain whether responses differed for novice and veterans educators. Of the 142 veteran educators that responded, 88%, or 125 reported that they did not participate in district competition within the last three years, and 90%, or nine of the ten novice educators indicated the same. While the percentages are almost equal it is important to note that the small size of novice educators within the sample may not represent an accurate comparison for that category.

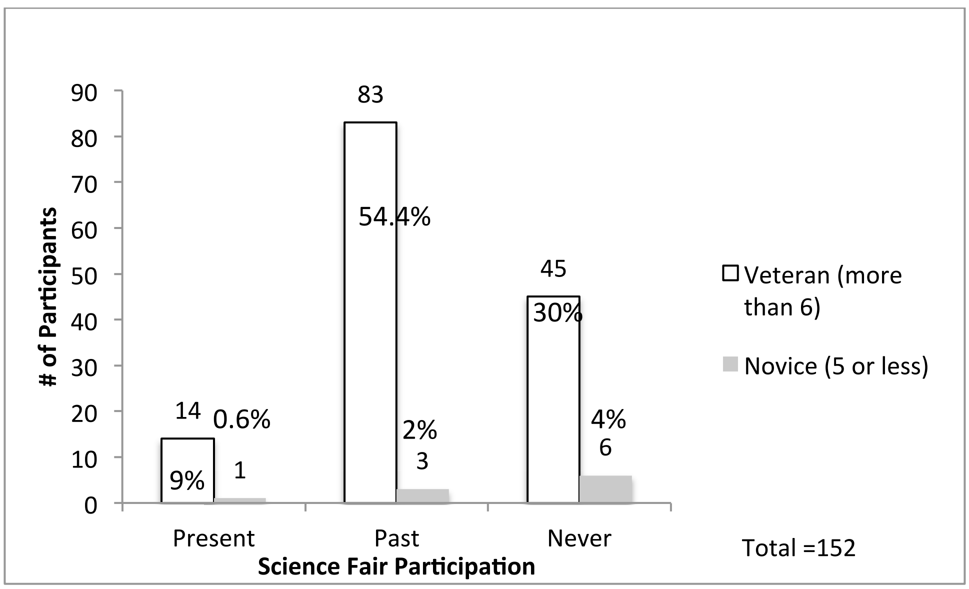

Figure 8. Science fair participation by educator experience

The decline has continued with 104 participants in 2016 and 93 in 2017 representing schools in the four counties of Ashtabula, Columbiana, Mahoning, and Trumbull, a decrease of 399 student entries since 2001 (Appendices D).

Two respondents indicated inconveniences in participating in the District 15 Competition from the university website used for registration such as difficulty in acquiring needed information from the district website, confusing and cumbersome registration requirements, Academy of Science restrictions, transporting students, and the problems incurred with a Saturday event. Two additional high school educators expressed their desire to participate in other competitions, outside of science fair, that focus on content specific to their high school curriculum.

Barriers/Obstacles to Science Fair Decline

Research Question 3. What factors are identified as barriers or obstacles that have led to the decline of science fair by preventing educators from participating in science fair?

Lack of time as an obstacle

The factor that posed the greatest obstacle for the inclusion of science fair by teachers into the classroom curriculum was reported to be the element of time. Respondents, at a rate of 90% (Table 7), chose time as the main challenge to the inclusion of science fair. At a rate of 81% time again was chosen in an additional question, as a valid reason for not participating in science fair. The write-in comment section listed numerous recent state and district imposed requirements that added to teachers' already overburdened load, such as preparation of student learning objectives, and preparing and administering annual pre/post testing for various groups of students. New teachers have additional demands on time because of completing state imposed Resident Educator Summative Assessment requirements (RESA) for their first four years.

Table 7. Time as an obstacle

Survey Question: Lack of time poses an obstacle to producing a successful science fair							
Strongly Disagree	Disagree	Undecided	Agree	Strongly Agree	Total	Mean	SD
0.6% 1	5.0% 8	3.7% 6	45.6% 73	45.0% 72	160	4.29	0.81

Lack of finances as an obstacle

The factor that ranked second as an obstacle for conducting science fair, at a rate of 70%, was lack of finances (Table 8). In an additional question 69% of respondents agreed finances were a valid reason for not conducting a successful science fair. The mean score of both responses were similar at 3.67 and 3.75 (Table 8).

Given that science fair requires little financial resources, underlying reasons for this response could again be a lack of familiarity with the accepted model of science fair, limited financial resources for school districts, or both. Unfamiliarity with science fair was a choice by 55%, reinforcing this supposition (Figure 9). This aligns with the 33% of respondents never participating (Table 4). There are 45% (Figure 9), of educators surveyed who have some or extreme familiarity with science fair from past experiences that are stating both lack of time and finances as obstacles. A possible interpretation of these two selections may be that they are familiar with science fair, but the model they have been exposed to might not be the accepted model of science fair.

Table 8. Lack of Finances

Survey Ques.: Lack of finances pose an obstacle to producing a successful science fair.

Strongly Disagree	Disagree	Undecided	Agree	Strongly Agree	Total	Mean	SD
4.4%	13.2%	13.2%	41.5%	27.7%			
7	21	21	66	44	159	3.75	1.13

Too many teaching duties as an obstacle

Too many teaching duties were reported as a major obstacle by 66% of the respondents as a reason for not participating in science fair (Table 9). This may leave little time for science fair preparation, collaboration with other staff or other required tasks, all fundamentally necessary for a correctly structured science fair. There were 19% of respondents who didn't indicate teaching duties as an obstacle and 16% were undecided

Table 9. Too many Teaching Duties

Survey Question: Too many teaching duties pose an obstacle to producing a successful science fair

Strongly Disagree	Disagree	Undecided	Agree	Strongly Agree	Total	Mean	SD
2.6%	16.2%	15.5%	40.9%	24.6%			
4	25	24	63	38	154	3.69	1.09

Shift in reading and math test score emphasis as an obstacle

Another major obstacle reported by 58% of respondents for not including science fair, was the shift in emphasis to reading and math preparation and administration of testing (Table 10). A 24% response rate indicated this was not an obstacle and 18% were undecided.

The emphasis on math and reading suggests more time and resources may be allocated for those subjects and less for science as indicated in research cited previously. Administration may support science fair, but not allocate time when reading/language arts and math scores are emphasized. The common variable for all above-mentioned reasons is time.

Table 10. Shift in Emphasis to Reading & Math Test Scores

Survey Question: Does the shift to reading and math poses an obstacle to producing a successful science fair

Strongly Disagree	Disagree	Undecided	Agree	Strongly Agree	Total	Mean	SD
1.9%	22.8%	17.6%	39.8%	17.6%			
3	35	27	61	27	153	3.48	1.09

Comfort Level and Familiarity with science fair and OAS Rules as an obstacle

The Ohio Academy of Science rules & regulations governing science fair outline the rules that must be adhered to for the process of completing a science fair project. The rules and regulations are to ensure uniformity in all local, district, state and international competitions. Students must follow the rules and regulations to ensure eligibility for entry into all competitions. Respondents overall, at a rate of 55% were unfamiliar with them (Figure 9).

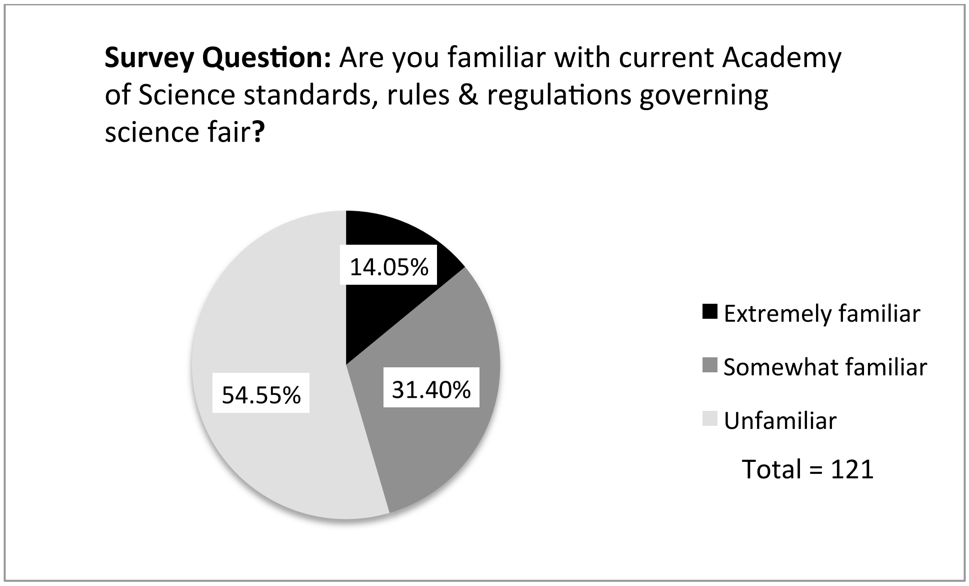

Figure 9. Respondent familiarity with OAS Rules & Regulations perceived as an obstacle for a successful science fair.

When subsets for novice and veteran educators were analyzed further, the 1-2 year teachers exhibited the highest unfamiliarity at 67% which was expected due to less exposure with fewer years in the profession (Table 11). The second novice group with 3-5 years displayed a 50% unfamiliar rating similar to veteran teachers six to ten years and more than ten years at 53% and 54% respectively for unfamiliarity. High school grade levels reported a range of 61%-63% unfamiliar rating and middle school grades had more uneven results. The seventh grade level reported an unfamiliarity rate of 70%, eighth grade 57%, and multiple middle grades at 31%. This lower rate of middle grades might reflect their higher relative current participation rate in science fair (Figure 7).

Table 11. Respondents Familiarity with OAS Rules & Regulations Governing Science Fair.

Variable	Extremely familiar		Somewhat familiar		Unfamiliar		Total	Mean	SD
	n	%	n	%	n	%			
Grade Level									
7^{th} Grade	13	11.1%	5	18.5%	19	70.4%	27	2.59	0.68
8^{th} Grade	3	13.0%	7	30.4%	13	56.5%	23	2.43	0.71
Multiple 7/8	5	38.5%	4	30.8%	4	30.8%	13	1.92	0.83
9^{th} Grade	5	27.8%	2	11.1%	11	61.1%	18	2.33	0.88
10-12 Grade	7	11.9%	15	25.4%	37	62.8%	59	2.51	0.70
Experience									
1-2 years	0	0.0%	1	33.3%	2	66.7%	3	2.67	0.47
3-5 years	2	25%	2	25%	4	50%	8	2.25	0.83
6-10 years	1	5.9%	7	41.2%	9	52.9%	17	2.47	0.61
more than 10	14	15.2%	28	30.4%	50	54.4%	92	2.39	0.74

Comfort level for implementing a classroom science fair was greater than comfort in conducting a school wide fair (Table 12). This was consistent for all grade levels when the results were analyzed further. These results were expected, as teachers conducting an activity in their classroom with their own students would give them more control, producing a mean of 4.09 comfort rating for classroom science fair and a mean of 3.46 for a school-wide science fair (Table 13). Coordinating an event outside of the classroom might require staff collaboration, facilities, and variables identified as obstacles for producing a successful science fair.

Table 12. Overall confidence in conducting a classroom science fair

Survey Question: At what level would you rate your confidence in conducting a classroom science fair?

Extremely Uncomfortable	Uncomfortable	Somewhat Uncomfortable	Somewhat Comfortable	Comfortable	Extremely Comfortable
2.6%	8.6%	17.1%	35.0%	22.2%	14.5%
3	10	20	41	26	17
			Mean = 4.09	SD=1.24	n = 117

Table 13. Overall confidence in conducting a school-wide science fair.

Survey Question: At what level would you rate your confidence in conducting a school-wide science fair?

Extremely Uncomfortable	Uncomfortable	Somewhat Uncomfortable	Somewhat Comfortable	Comfortable	Extremely Comfortable
9.3%	21.2%	17.8%	24.6%	20.3%	6.8%
11	25	21	29	24	8
			Mean = 3.46	SD=1.43	n = 117

The comfort range for implementing a classroom science fair was fairly consistent throughout grade levels seven through twelve with the range of means from 4.11 to 4.43 out of six (Table 14). There appeared to be a greater range, 2.86 to 3.53 in mean, showing less confidence when comparing novice and veteran teachers (Table 15), as one would expect, due to fewer years in the profession to have direct experience with science fair or indirect exposure by another staff member who participates.

Table 14. Middle and High School teacher confidence in conducting a classroom science fair as an Obstacle

Survey Question: At what level would you rate your confidence in conducting a classroom science fair?

Extremely Uncomfortable	Uncomfortable	Somewhat Uncomfortable	Somewhat Comfortable	Comfortable	Extremely Comfortable	Total	Mean	SD
7th Grade								
3.7%	7.4%	14.8%	29.6%	25.9%	18.5%			
1	2	4	8	7	5	7	4.22	1.31
8th Grade								
0.0%	8.7%	17.4%	14.2%	21.7%	26.0%			
0	2	4	5	6	6	23	4.43	1.28
Multiple Grade 7/8 Grade								
0.0%	0.0%	33.3%	25.0%	16.7%	25.0%			
0	0	4	3	2	3	12	4.33	1.18
9th Grade								
5.8%	0.0%	25.5%	41.2%	17.6%	17.6%			
1	0	3	7	3	3	17	4.18	1.25
10-12 Grade								
1.7%	8.7%	15.8%	40.3%	17.5%	15.8%		4.11	1.21
1	5	9	23	10	9	57		

The results when comparing veteran and novice educator subgroups were unexpectedly close when comparing the mean for comfort with school-wide science fair (Table 15). Novice educators, three to five years and one to two years, had a mean range of 2.86 to 3.33 respectively, and veteran educators, ten or more years and six to ten years, displayed a mean of 3.50 and 3.53 respectively, with veteran teachers seeming slightly more comfortable with the process. These results may be slightly skewed with a higher mean than expected for the novice one to two year category as one first year teacher expressed a comment having extensive participation in science fair acting as a judge in district, and state level as well as being a student participant for many years progressing to the state competition.

Table 15. Veteran and Novice teacher confidence in conducting a school-wide science fair as an Obstacle for a Successful Science Fair.

Survey Question: At what level would you rate your confidence in conducting a school-wide science fair?

Extremely Uncomfortable	Uncomfor table -	Somewhat Uncomfortable	Somewhat Comfortable	Comfortable	Extremely Comfortable	Total	Mean	SD
Novice 1-2 years								
0.0%	33.3%	0.0%	66.6%	0.0%	0.0%			
0.	1	0	2	0	0	3	3.33	0.94
Novice 3-5 years								
0.0%	57.1%	14.3%	14.3%	14.3%	0.0%			
0	4	1	1	1	0	7	2.86	1.12
Veteran 6-10 years								
5.9%	17.6%	25.5%	35.3%	5.9%	11.7%			
1	3	4	6	1	2	17	3.53	1.33
Veteran more than 10 years								
11.1%	18.9%	16.7%	22.2%	24.4%	6.6%			
10	17	15	20	22	6	90	3.50	1.48

Support by Administration, Staff, and Parents as an obstacle

When combining the agree and strongly agree columns, administrative support was perceived as an obstacle by 23% of respondents, followed by staff support at 35%, facilities and logistics at 50%, parental support at 52%, and lack of incentives at 63% (Table 16). The staff support may be needed for cross-curricular components such as scheduling computer usage, cooperation with the language arts teacher for student reports and math teacher for chart assistance. Parental support is needed for purchasing the display board, checking periodically that the student adheres to the timeline and transporting the student to the district competition should they qualify. Administrative support consists of authorizing changes in schedules and coordinating logistics for the science fair and providing incentives to assist the teacher. Respondents reported at 50% that facilities and logistics posed an obstacle. They seem to have lack of space or scheduling difficulty when implementing science fair. A follow up question would have clarified their need. It is also worth noting that support from each group varies on the model of science fair that is implemented (Table 20).

Table 16. Staff, Parent, Administrator Support, & Incentives and Facilities as Obstacles for a Successful Science Fair.

Survey Question: Does the following pose an obstacle to producing a successful science fair.

Strongly Disagree	Disagree	Undecided	Agree	Strongly Agree	Total	Mean	SD
Staff Support							
5.1%	32.0%	28.2%	26.9%	7.7%			
8	50	44	42	12	156	3.00	1.05
Parental Support							
0.6%	23.9%	23.3%	30.1%	22.0%			
1	38	37	48	35	159	3.49	1.10
Administrative Support							
8.4%	44.1%	24.6%	19.5%	3.2%			
13	68	38	30	5	154	2.55	0.99
Lack of Incentives							
3.2%	17.4%	16.1%	48.4%	14.8%			
5	27	25	75	23	155	3.54	1.04
Facilities/Logistics							
5.7%	31.2%	13.3%	36.9%	12.7%			
9	49	21	58	20	157	3.20	1.18

Lack of student interest as an obstacle

Respondents reported student interest as a barrier to implementation of science fair at a rate of 59%, with 24% undecided and 17% disagreeing (Table 17). When science fair is presented to students as a project with a deadline, it can be viewed by the student as another assignment and not garner much enthusiasm. Additional write-in comments by respondents reinforce this perception with the statement, “they don’t want another project to complete.” Science fair presented to students as another project, rather than a problem solving activity may hinder student interest. A teacher who seems to perceive science fair important enough for the curriculum wrote, “I have created a unique design in getting all students to participate”.

Table 17. Student Interest

Survey Question: Lack of student interest poses an obstacle to producing a successful science fair.

Strongly Disagree	Disagree	Undecided	Agree	Strongly Agree	Total	Mean	SD
2.5%	14.6%	24.0%	40.5%	18.3%			
4	23	38	64	29	158	3.58	1.03

Strong science background, familiarity with project-based learning, and state science standards as an obstacle

The majority of respondents did not seem to view teacher experience with project-based learning, need of a strong science background, or alignment with state standards as obstacles to science fair participation (Table 18). This was confirmed with a high percentage of disagreement and a low mean score ranging from 2.50 to 2.75 for those items. The reported response rates indicate that teachers are aware state standards and project-based learning correlate with science fair.

Table 18. Teacher’s Science Background, Experience with Project-based learning, & State Standards as an obstacle

Survey Question: Does the following pose an obstacle to producing a successful science fair.

Strongly Disagree	Disagree	Undecided	Agree	Strongly Agree	Total	Mean	SD
Teacher Experience with Project-based Learning							
11.39%	39.8%	17.7%	24.7%	6.3%			
18	63	28	39	10	158	2.75	1.14
Strong Science Background of Teacher							
16.9%	39.8%	17.7%	24.6%	6.3%			
18	63	28	39	10	158	2.75	1.13
Relevancy to State Science Standards							
12.3%	46.1%	22.8%	13.6%	5.8%			
19	71	34	21	9	154	2.55	1.06

The Value of Science Fair

Research Question 4 states, **‘**What is the perceived value of science fair with regard to Ohio Science Learning Standards, OAS Science Fair Standards, different science fair models, and alternative STEM competitions and/or activities?’ Each of the components will be addressed separately in the following section.

Ohio Revised Learning Standards for Science & OAS Science Fair Standards

To determine if educators viewed science fair as a tool to teach the state standards, questions were framed to gauge whether teachers understand the guiding principles woven into all grade levels of the state science standards and whether they know the pedagogical value of science fair as it relates to those standards. An indication that teachers value science fair was determined by a low current participation rate of 10% (Table 4), yet an overwhelmingly positive response rate of 92% (101/110), when asked if they wanted to attend a science fair workshop for professional development. Two comments reinforcing the associated value were, “I believe they are a worthwhile experience that can lead to increased science learning”, “I have created a unique design in getting all students to participate.”

Table 18 indicates strongly that educators are aware that science fair standards directly coincide with scientific inquiry, analytical and critical thinking skills, project-based learning, and the process of science, all identified by 90% or more of respondents as included in science fair. All four of the previous mentioned concepts are incorporated into the state science standards, and teachers rated correlation of standards to science fair at a rate of 68%. Teachers, at a rate of 32%, seem to have a misconception of the current standards. The lowest rating given to descriptors of science fair was the correlation of science fair to the current state test at 53%. At a rate of 68% respondents agreed, (Table1 19), that science fair standards are relevant to state science standards. The data from Table 9 displayed a lower rate of 58% of respondents indicating that science fair standards are in alignment with state standards.

Table 19. Respondents Perception of Science Fair Descriptors.

Survey Question: The following is descriptive of science fair.

Strongly Disagree	Disagree	Undecided	Agree	Strongly Agree	Total	Mean	SD
Students learn through inquiry and problem solving							
0.0%	0.7%	3.9%	58.7%	36.8%			
0	1	6	91	57	155	4.32	0.58
Students practice project-based learning							
0.0%	1.9%	8.4%	56.8%	32.9%			
0	3	13	88	51	155	4.21	0.67
Students apply the process of science							
0.0%	3.9%	4.5%	58.7%	32.9%			
0	6	7	91	51	155	4.21	0.70
Students utilize analytical & critical thinking skills							
0.65%	2.6%	7.1%	55.2%	34.4%			
1	4	11	85	53	154	4.20	0.73
Relevant to current state science standards							
1.28%	10.9%	19.9%	55.8%	12.2%			
2	17	31	87	19	156	3.67	0.87
Cross-curricular involving multiple disciplines							
0.0%	7.7%	13.6%	60%	18.7%			
0	12	21	93	29	155	3.9	0.79
Addresses the content in current mandatory state test							
4.5%	14.1%	28.4%	43.2%	9.7%			
7	22	44	67	15	155	3.39	0.99

Science Fair Models

Table 20 suggests science fair has different meanings to different science educators. Assigning a project to a student to complete at home is the definition reported by 18% of respondents and 6.0% responded that displaying a scientific principle is a science fair project. When given characteristics of different models of science fair 27% of all respondents identified the model that emulates science fair as described by the Academy of Science, 24% identified the incorrect model and 38% have never participated (Table 20). The 27% respondents who have the accurate representation of science fair have made the connection between the true model of science fair embracing the state standards. One of the 32 written responses stated, "students complete projects that are not necessarily testable", which is required for the true model of science fair. Another stated, "I assign independent projects with a presentation and report", and a third described that," students complete all projects in class", and a fourth said, "students demonstrate their knowledge of the science process when completing labs in class", indicating that participants touch on components of science fair in their curriculum.

The question asked of the respondents was not worded clearly enough to ascertain whether the respondents are using the model of choice or one of necessity due to their environment. It asked which model do you use or have used in the past; instead of asking which model they prefer if they had the necessary resources. This would have identified the model they equate with science fair and would have left no question as to their knowledge of the science fair model. They may be prevented from using the correct model because of obstacles mentioned in the survey questions. So the question might not have yielded valid results.

Table 20. Perceptions of Science Fair Models

Survey Question: Which model of science fair Model resembles the science fair utilized in your school/district today or in the past?		Total
		113
Teacher assigns a query and on their own the student gathers and assembles the project at home.	20	17.70%
Student in consultation and continuing guidance with teacher chooses a query and works with a mentor to test their hypothesis.	31	27.43%
The project, assigned or chosen, is not a query but a display of a science principle.	7	6.19%
We have never participated in science fair.	43	38.05%
Other (written comments)	12	10.62%

Alternative STEM Activities

Educators reported that they participate in other STEM activities besides science fair at a rate of 73%, with middle school grade levels reporting at a rate of 68% and high schools participating in alternative STEM activities at a rate of 71% (Table 21). One educator responded in the open ended questions, that their school participated in science fair in past years, but chose to compete in STEM Believe in Ohio this year. Other respondents reported participating in Bridge building competitions, Egg drop events, Lego Challenges, and the Penguin Bowl. Lego Challenge and the Penguin Bowl are activities for a group of select students, not a class activity. Bridge Building and Egg Drop Competitions are university-sponsored events where a class can participate, but is limited to a class. None of these activities are for all students as is science fair.

Table 21. Alternative STEM Activities

Survey Ques. Does your school participate in other STEM activities?

	Yes	No	Total
Middle School Respondents	70%	30%	100%
High School Respondents	73%	27%	100%
All Respondents	73%	27%	100%
n=157	114	43	157

A follow up question may have given further insight as to the reason educators are choosing alternative STEM activities instead of science fair. Due to educators' demanding schedules and the desire to keep the survey short to increase response rate the question was not included in the survey. The high percentage of recipients choosing to list other competitions and events in lieu of science fair supports the research stating that alternative STEM activities have drawn down from science fair participation, adding to the decline.

Research Question 5. What measures are perceived as important implementations of science fair?

Scholarship monies

Survey results indicated the needs associated with implementing a successful science fair. At a rate of 84% determined by combining strongly agree and agree categories and a mean of 4.10 (Table 22), respondents indicated scholarship money is the most important measure as an incentive for their students. Scholarships, dedicated budget and fiscal incentives at 84%, 83% and 81% respectively, were among the top five needs expressed by respondents, when combining the agree and strongly agree columns on Table 22. Fiscal incentives had a slightly higher mean than dedicated budget at 3.99 and 3.92 respectively.

Table 22. Monies as a Need to Implement Science Fair

Survey Ques.: The following implementations would help in initiating science fair.

Strongly Disagree	Disagree	Undecided	Agree	Strongly Agree	Total	Mean	SD
More scholarship money							
0.0%	1.9%	14.1%	56.4%	27.6%			
0	3	22	88	43	156	4.10	0.70
Dedicated budget							
0.6%	5.8%	10.3%	67.9%	15.4%			
1	9	16	106	24	156	3.92	0.73
Fiscal incentives							
0.0%	7.1%	11.6%	56.8%	24.5%			
0	11	18	88	36	155	3.99	0.80

The Need for Mentors/Coaches and Facilitators

The two needs designated least by respondents were mentors or coaches at 69% and a facilitator to assist the teacher (Table 23). Although rated last, with a rate of 63% for mentors or coaches they displayed similar means of 3.71 for coaches and 3.56 for facilitators.

Table 23. Coaches and Facilitators as Needs to Implement Science Fair

Survey Ques.: The following implementations would help in initiating science fair.

Strongly Disagree	Disagree	Undecided	Agree	Strongly Agree	Total	Mean	SD
Project coaches							
0.6%	10.9%	19.9%	54.5%	14.1%			
1	17	31	85	22	156	3.71	0.86
Science fair facilitator							
2.6%	15.4%	18.6%	50.6%	12.8%			
4	24	29	79	20	156	3.56	0.98

Science, Business, University Involvement, Educator Networking, & Professional Development

The involvement of the science community at 83% and educator networking at 82% were needs expressed of respondents with similar means of 3.97 and 3.95 respectively (Table 24). They further agreed on the importance for teacher professional development at 77% and university and business outreach at a similar rate of 76% for a successful science fair program with slight variations of mean, 3.87, 3.89, and 3.86 respectively (Table 24).

Table 24. Science Community Involvement, Educator Networking, Professional Development, University & Business Outreach as Needs to Implement Science Fair

Survey Ques.: The following implementations would help in initiating science fair.

Strongly Disagree	Disagree	Undecided	Agree	Strongly Agree	Total	Mean	SD
Science community involvement							
0.6%	3.2%	12.8%	64.7%	18.6%			
1	5	20	101	29	156	3.97	0.71
Educator networking							
0.0%	4.5%	13.4%	64.9%	17.2%			
0	7	21	102	27	157	3.95	0.69
Teacher professional development							
1.3%	7.1%	15.4%	56.4%	19.9%			
2	11	24	88	31	156	3.87	0.86
University outreach							
1.3%	5.1%	17.8%	55.4%	20.4%			
2	8	28	87	32	157	3.89	0.83
Business community involvement							
0.6%	5.1%	18.6%	58.9%	16.7%			
1	8	29	92	26	156	3.86	0.77

More than 50% respondents agreed to the need for all implementations with a range of 63% to 83% and a mean range of 3.56 to 4.10.

Summary

Educators reported that they view science fair positively in value and report that it aligns with the Ohio Science Learning Standards, but less than 73% failed to recognize the true model of science fair, and a small percentage, 10% are currently implementing science fair. The high unfamiliarity and comfort level reported by respondents for implementation of science fair may be the reason educators state lack of finances as a high need and use of mentors and facilitators much lower. Science fair requires little funds to implement and more time is made available to teachers through the use of mentors and facilitators.

An overview of the findings of the study is discussed in the following chapter with implications for professional practice and recommendation for further research.

CHAPTER V

DISCUSSION

Introduction

If one believes the responsibility of public education is to prepare students to be effective citizens of a participatory democracy, then the reader and researcher are of one mind. The question that was the genesis for this research was what role does the public school science curriculum play in fulfilling that responsibility?

With the introduction of state and federal mandated performance goals and validation through testing in selected subjects, the researcher observed a slow but steady withdraw of a highly effective teaching tool in shaping students for their role in society, the school science fair. Students exposed to and experienced in science fairs through grade level progression are instilled with the concept of experimental validation. This is a 21st century term for what has been around since Galileo, the scientific method, or science process. Providing students with this cross-curricular critical thinking skill allows them the opportunity to not only be better students, but effective consumers and political decision makers through out life.

Why and how did such an obvious valuable teaching tool fall from favor with teachers, curriculum designers, and administrators? Why were schools abandoning a method that turned out such illustrious scientists who went on in later years to capture Nobel Prizes, Fields Medals, the National Medal of Science and countless students whose critical thinking skills were first developed through science fair participation? Why were schools now investing and buying into many educationally narrow activities that focus on selected careers? These and other questions needed investigation.

The observed decline of science fair participation required examination. Questions were composed to identify the reasons for the decline in participation, ascertain educators' views on the value of science fair as a curriculum tool to teach the science standards, and assess the importance and relevance of science fair. This inquiry will offer one possible path to mitigating the decline in science fair.

Findings of Study

Respondents

Invitations were sent to 600 teachers, principals, superintendents and curriculum specialists in the four counties comprising District 15 of the Ohio Academy of Science. Respondents totaled 162, 98% of which were from the public schools. The respondents were less diverse than the total population of the four counties. Parochial and Charter schools participate in science fair at an equal or higher rate than public schools and their lack of participation in the survey limited the results. Educators new to the profession responded at a low rate of 6.0%, while the vast majority of respondents were veteran educators investing ten or more years in the field. The low number of new teacher respondents did not affect the results as they would not have had science fair experience to share because they were not teachers when science fair was popular. One new teacher shared science fair experience from the perspective of their involvement as a student.

Veteran educators, those with six or more years in the educational field elected to respond at a rate of 92%. Those with ten or more years were represented at a rate of 82%; these respondents had an additional perspective to share, for their experience spanned the time when science fair was prominent, under the previous state standards. Veteran educators participated in science fair in the past, at a rate of 55% but currently participate at 9% showing a decrease of 46%. Under prior state standards that were less similar to OAS science fair standards these educators participated at a higher rate than they do now. The New Ohio Learning Standards are formed from the OAS affiliate NRC that promotes science fair and includes all of the science fair standards, so the question arises why did they stop including science fair when it is ever more present in the new curriculum? Science fair has not changed; it is a tool to teach the standards to all students yielding positive results with a pipeline effect that encourages those interested in the STEM field to pursue careers in that field, and it teaches others who are interested in other paths how to solve a problem logically, with fact-based testable evidence for life skills. That leads one to think that there must be something obstructing teachers from implementing science fair.

Participation

Over the course of the past few years a decrease in public school participation has been observed by this researcher who is a Science Council Member involved in the District 15 Competition. Data has not been compiled to distinguish public school participants from non-public school participants in the past, but the greatest number of science fair projects observed was from the public schools. In 2017, only five public schools from the four county area, participated in District competition. Public school participants numbered 33, parochial 28, and charter schools sent 29 students. It was this decline that initiated the concern over the loss of this very useful and effective curriculum instrument that teaches the skills of critical thinking and problem solving, communication and collaboration, creativity and innovation, often referred to as 21st century skills.

Even with the absence of charter and parochial school input it was an important to have the public school represented in this study since their participation rate was observed to be the lowest, but it would have been helpful to understand why only public school participation is declining at such a severe rate. Charter and parochial curricula has the absence of state testing which may afford them more time and flexibility to include science fair. Respondents stated through survey questions and open-ended comments that they had little time due to testing and other mandates.

Obstacles Identified

A common thread throughout survey responses was the lack of time in the classroom teacher's schedule to address any more initiatives. Science fair seems to be thought of as an add-on, or another initiative, instead of a tool to teach the standards. Teachers do not seem to equate science fair with the state standards even though they identified the science fair descriptors with 90% accuracy. That only leaves one to assume teachers are not fluent in the state standards. This misconception of science fair and/or standards may be due to the high level of unfamiliarity with the correct model of science fair and its implementation. When science fair is correctly implemented it does not take time away from teaching the standards.

Some identifying time as their main obstacle to the implementation of science fair followed up with comments such as," I must focus on state standards", "I have a multitude of duties other than teaching", "I must complete new mandates including The RESA" and "We are assigned other school related activities". The RESA, or Resident Educator Summative Assessment Program in Ohio is a four-year program for new teachers earning them eligibility to obtain a teaching license.

Subdividing the data into counties, confirmed the decline, but did not yield useful data, as Ohio schools are not structured for county systems. Each district uses the same state standards but implements them with different strategies, teaching techniques and methods, fewer electing to infuse science fair into the curriculum. It was one of the intents of the survey instrument to elicit responses to determine the reasons science fair has been excluded from the respondents who once participated but no longer participate.

With a response rate of 96% recognizing the scientific process, 93% for project-based learning, and a rate of 90% analytical and critical thinking, educators agreed that science fair includes the methodology of inquiry using the scientific process and problem solving skills. These three variables were included in the New Learning Standards for Science, formulated by the National Research Council (NRC), an affiliate of the Academies of Science, a proponent of science fair. If the new standards include the three skills that are components of science fair, it would be presumed that teachers would embrace science fair. Knowledge of the state standards should have increased science fair participation, but the opposite has occurred. Educators responded to two different questions, both assessing state standard relevancy to science fair having response rates of 58% and 68% stating that state standards are relevant to science fair. If state standards include science fair standards and teachers overwhelmingly identified science fair standards correctly at 90-95**%** then it is something other than the standards themselves that are discouraging teachers from implementing science fair.

State content testing was seen as an obstacle for science fair implementation. When asked if state test content was addressed in science fair standards the rate of response for agreement was 53% and a 28% rate for those undecided. It may therefore be assumed that teachers see a disconnect between state standards and the state mandated test. Another possibility is that teachers are emphasizing grade level content included on state tests in their curriculum at the expense of the overall standards of critical thinking and problem solving, communication and collaboration, creativity and innovation.

Five respondents expressed through write-in comments that they were encouraged by their administration to use classroom time to focus on increasing test scores resulting in no time for science fair. The insertion of one separate question in the survey connecting state testing to science fair participation would have yielded more definitive results.

Testing was addressed in another question, but this was not directed at science content exams, rather emphasizing math and reading tests implemented in 2001with the passage of the No Child Left Behind act (NCLB) as an obstacle to the implementation of science fair. Schools were penalized for low scores and resources diverted to support math and reading at the expense of science. This has more of an impact at the elementary level but grades five and six were not included in this study, however 40% of respondents agreed with the statement and 18% strongly agreed. From personal and professional experience in the classroom, students entering middle school were unprepared for science because the elementary principal was using science resources such as funds and time to support reading and math. There is a strong possibility that the respondents who answered positively may have shared the same experiences. The insertion of one separate question in the survey connecting state testing to science fair participation would have yielded more definitive results.

Two needs, undervalued by respondents, were a facilitator and mentors that free up teachers' time. Mentors or coaches are specialists in the selected field to assist the student with use of lab facilities and supplies during the testing phase. A facilitator would assist the teacher in the area of time by preparing student templates needed for research papers, constructing time lines, student guide books and obtaining mentors and parent helpers for the science fair, as well as coordinating the facilities needed for the fair with an administrator. If lack of time is rated the number one obstacle, then lack of time may have been a reason for not having mentors for students. If this supposition is correct, then a facilitator may be very valuable to the teacher. The position of a science fair facilitator could be provided by local universities, county educational service centers, or local school districts. This role would be introduced and developed through professional development and explained how mentors will be recruited, trained and used in the curriculum.

Another obstacle lessening participation in school-wide and district participation may be lack of exposure to the Ohio Academy of Science Rules and Regulations, which 55% rated as unfamiliar with them. Teachers must visit OAS website for forms, rules and requirements for their students. Students can follow any rules a teacher puts forth in the classroom, but if one participates in a school-wide fair where winners advance to the district, then compliance with the rules must be in place to ensure eligibility. If, as indicated, teachers lack time then they are not getting the required information resulting in them forgoing science fair.

Teachers rated comfort level with a classroom science fair at 37% and a school-wide fair at 27%. They were also asked to select the correct model of science fair from three choices with a response rate of 27%. The remaining 73% either have a misconception of the model of science fair or have never participated at all. It would be assumed that this population would not feel comfortable with implementing science fair. This would be an opportunity where a facilitator could help with all facets of implementation thereby easing the comfort level for teachers. Ironically, when science fair is implemented correctly it can enhance and fulfill the state curriculum objectives without sacrificing time. With 33% of respondents never conducting a science fair, it is possible that unfamiliarity with the process is more the problem than time.

Educators identified lack of finances as the second highest obstacle next to time, at a rate of 69% and a need for a dedicated budget at 83% in order to initiate science fair. It was surprising to see monetary issues rated as high a need, as science fair requires little monies for ribbons and display boards for students unable to purchase them.

Teachers in grades seven through twelve identified the need for more scholarship money to help entice science fair participation. This may be seen as an incentive to elevate student interest, as educators, at a rate of 59% identified student interest as an obstacle to science fair implementation. Student interest may be addressed through professional development to share ideas of garnering student interest.

Scholarships in past years, at the district level, were awarded to high school juniors and seniors. Scholarship money was included as the top prize at the district level, but has not been provided for many years. These monies are still offered at the state level, but if teachers no longer participate they may not be aware.

Teachers would also like to see the science community become involved in science fair at a rate of 83%. The science and business community can assume a mentor role for students whether it be local university professors, science professionals in local businesses, government, and non profit agencies. All of these can be opportunities and resources assisting students with their projects.

Faculty networking was a need specified by 82% of respondents to initiate science fair. This recognizes the true model of science fair as a cross-curricular experience identified by 79% of respondents.

Although state monies for public education are shrinking, this would not be a problem attributed to the decline in science fair, where very little money is needed. Again, this may be more of a misperception of science fair.

The value of science fair was not asked directly but could be implied when educators responded to the descriptors of science fair and identified the key elements including inquiry and problem solving, project-based learning, the science process, and analytical and critical thinking skills at a rate at or above 90%. Educators were asked if they would like to attend a science fair professional development workshop in which 64% responded favorably.

Respondents reported that 73% are engaged in other STEM activities besides science fair. Many alternative STEM activities are short-range activities, lasting one or two days compared to science fair, which historically is introduced as a class-wide required assignment in September and culminating in February or March. Teachers may therefore be choosing these events based on the relatively short time they need to be completed. However, these activities do not include all the components of science fair that are mandated in the state science standards.

Three comments by high school educators stated they thought science fair was a middle school concept. Their past experience with science fair was most likely at the middle school level and that perception would not lead them to consider adding it to their curriculum, another possible reason for decline in participation.

Limitations and Further Studies

Charter and Parochial schools were underrepresented in this study. A reason for the decline in science fair participation for public schools may be the demands placed upon them that the private, charter and parochial schools do not have. Teachers in the public schools gave a range of answers identifying mandates and responsibilities they must complete during the day that impedes them from implementing science fair, which begs the question, are non-public school employees required to complete the same mandates and responsibilities? Most do not, however some may elect to test students as do the public schools, but to the same extent? These questions need to be addressed to determine if the mandates placed upon the public school educators are the reason for the decline in science fair. Fewer public schools are participating while charter and parochial schools are participating at the same rate or greater than in the past. Further research needs to be conducted to include non-public schools to determine the different demands placed on educators from both types of systems and if those demands such as state testing, interfere with science fair implementation.

A second limitation to the study was the need to restrict the number of questions to 25. It was felt that educators would not participate if the survey was longer, due to their busy day. Additional questions would have determined the reason for schools choosing to implement STEM related activities other than science fair. The question asked in this survey determined that schools are electing to participate in other STEM activities and/or programs but not why.

The 'maker movement' a term coined for the infusion of business models and or technology under the heading of STEM, is creeping into the educational curriculum through such examples as 3D printing, code.org, and robotics. Many of these activities were originally funded though the Race to the Top Program of the Obama Administration that provided grants for new innovative ideas or programs. Science fair may have been cast aside when school districts persued badly needed money for a new program. Offering alternative STEM activities were identified by 73% of respondents. These activities do not satisfy all of the standards of science fair and are usually not provided to the general student population.

Within the past three years the Ohio Academy of Science has introduced two new programs that compete with science fair. The Believe in Ohio Competition initiated in 2015, is an entrepreneurship program for grades 9-12 which introduce STEM students to commercialization and business plan development for Ohio's next generation of STEM innovators,' (Believe in Ohio, 2017). This, unlike science fair, is a career-oriented program not rooted in teaching the scientific method. This type of program could serve as a follow up for the high school once science fair is taught in grades five through eight, and students demonstrate their proficiency of the science process. Invention Convention initiated in 2014 is an elementary program sponsored by the OAS with competitions for grades one through three, and four through six. Students follow the science process to develop a new product. This program may be used as a foundation to spur interest in science fair.

High school students comprised 3% of student participants at the 2017 District 15 Competition the most severe decline observed. It is not known if this trend is an isolated anomaly or if it is occurring in other districts. The reasons for this require more extensive questions than asked in the 25-question survey. To determine if this is statewide it would also require data from the Ohio Academy of Science.

Solutions:

A correct model of science fair starts with a teacher certified in the appropriate field of science. This is to assure content confidence and experience in the application of the scientific method. To meet this basic requirement, colleges of education must assume the responsibility to properly prepare the student teacher. Credit courses in the proper construct of a science fair for all variables, (locales, environments, resources, time, etc.), would lead to a student teacher having an advanced or added certification as a licensed science fair teacher by grade level. With such certification in place, the next level of buy-in moves from the university, to local district administration. Here superintendents and building principals in consult with OAS, faculty representatives, curriculum specialists and the certified science teacher, meet to develop strategies and action plans to incorporate science fair across the district at all levels into their curriculum. One of two key components of the strategy should include a plan to communicate with parents and local businesses in the district as to the new inclusion of the district's curriculum requirement. The other critical part of the plan would be to develop and schedule specialized workshops for assisting faculty (science fair is cross curricular) and parents in what each may expect in the way of student expectations, science fair procedures and required resources and time expenditures. In each workshop, it would be explained how an effective science fair experience meets state standards and how it is a long-term preparation for the student. Additionally, at the faculty workshops, the roles of coaches and mentors would be introduced. Teachers would learn how to access and apply mentors to the projects.

In meeting state standards through the teaching of the science fair experience, the classroom teacher must develop goals and lesson plans that span classroom time from

September to the culminating science fair in March. This requires the science teacher to teach daily lessons for each part of the scientific method. Each function, taken in order of the scientific method, such as, problem stating, observation, organization, research, data collection, recording, experiment design and execution, graphing, and presentation skills, becomes a lesson that is automatically aligned with the state standards. These daily, weekly and or monthly lessons, by design, address mandated standards and do not add work or demand additional classroom time. They simply efficiently and effectively replace lessons that up until now would have been individually written and taught. With this in place, the teachers' biggest concern and obstacle to implementing science fair, the lack of time, is no longer an issue.

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APPENDIX A - NEXT GENERATION SCIENCE STANDARDS

Source: (http://www.nextgenscience.org)

The National Research Council's (NRC) *Framework* describes a vision of what it means to be proficient in science; it rests on a view of science as both a body of knowledge and an evidence-based, model and theory building enterprise that continually extends, refines, and revises knowledge. It presents three dimensions that will be combined to form each standard:

Dimension 1: Practices

The practices describe behaviors that scientists engage in as they investigate and build models and theories about the natural world and the key set of engineering practices that engineers use as they design and build models and systems. The NRC uses the term practices instead of a term like “skills” to emphasize that engaging in scientific investigation requires not only skill but also knowledge that is specific to each practice. Part of the NRC’s intent is to better explain and extend what is meant by “inquiry” in science and the range of cognitive, social, and physical practices that it requires. Although engineering design is similar to scientific inquiry, there are significant differences. For example, scientific inquiry involves the formulation of a question that can be answered through investigation, while engineering design involves the formulation of a problem that can be solved through design. Strengthening the engineering aspects of the Next Generation Science Standards will clarify for students the relevance of science, technology, engineering and mathematics (the four STEM fields) to everyday life.

Dimension 2: Crosscutting Concepts

Crosscutting concepts have application across all domains of science. As such, they are a way of linking the different domains of science. They include: Patterns, similarity, and diversity; Cause and effect; Scale, proportion and quantity; Systems and system models; Energy and matter; Structure and function; Stability and change. The Framework emphasizes that these concepts need to be made explicit for students because they provide an organizational schema for interrelating knowledge from various science fields into a coherent and scientifically-based view of the world.

Dimension 3: Disciplinary Core Ideas

Disciplinary core ideas have the power to focus K–12 science curriculum, instruction and assessments on the most important aspects of science. To be considered core, the ideas should meet at least two of the following criteria and ideally all four:

- Have broad importance across multiple sciences or engineering disciplines or be a key organizing concept of a single discipline;
- Provide **a key tool** for understanding or investigating more complex ideas and solving problems;
- Relate to the interests and life experiences of students or be connected to societal or personal concerns that require scientific or technological knowledge;
- Be teachable and learnable over multiple grades at increasing levels of depth and sophistication.

Disciplinary ideas are grouped in four domains: the physical sciences; the life sciences; the earth and space sciences; and engineering, technology and applications of science

APPENDIX B - THE 2010 OHIO LEARNING STANDARDS IN SCIENCE

SCIENCE CONTENT BASED ON NATURAL WORLD EVIDENCE

Communicate results with graphs, charts, tables

Use evidence, scientific knowledge to develop explanations

Research books, other sources to gather known information

Plan and investigate

Organize, evaluate, interpret observations, measurements, other data

Use appropriate mathematics, technology tools to gather and interpret data

Identify. Ask valid and testable questions

EXPLAIN..EXTEND..EVALUATE

Teachers using the revised science standards will be able to:

• Scaffold their students in framing questions, grappling with data, creating explanations, and critiquing explanations (including others in public forum)– all important components of inquiry.

• Select instructional materials from the Model Curriculum that promote the teaching and learning of science by inquiry.

• Assess students' abilities in multiple ways that are compatible with inquiry.

Students engaging with grade appropriate science content in depth through the Scientific Inquiry/Learning Cycle will be better prepared to meet the challenges they will be confronting as they enter higher education or pursue a career.

Source: Ohio Department of Education Science Standards pg.6, June 2015 http://education.ohio.gov/getattachment/Topics/Ohio-s-New-Learning-Standards/Science/Science_Standards.pdf.aspx

APPENDIX C - OHIO ACADEMY OF SCIENCE (OAS) STANDARDS FOR A SCIENCE PROJECT

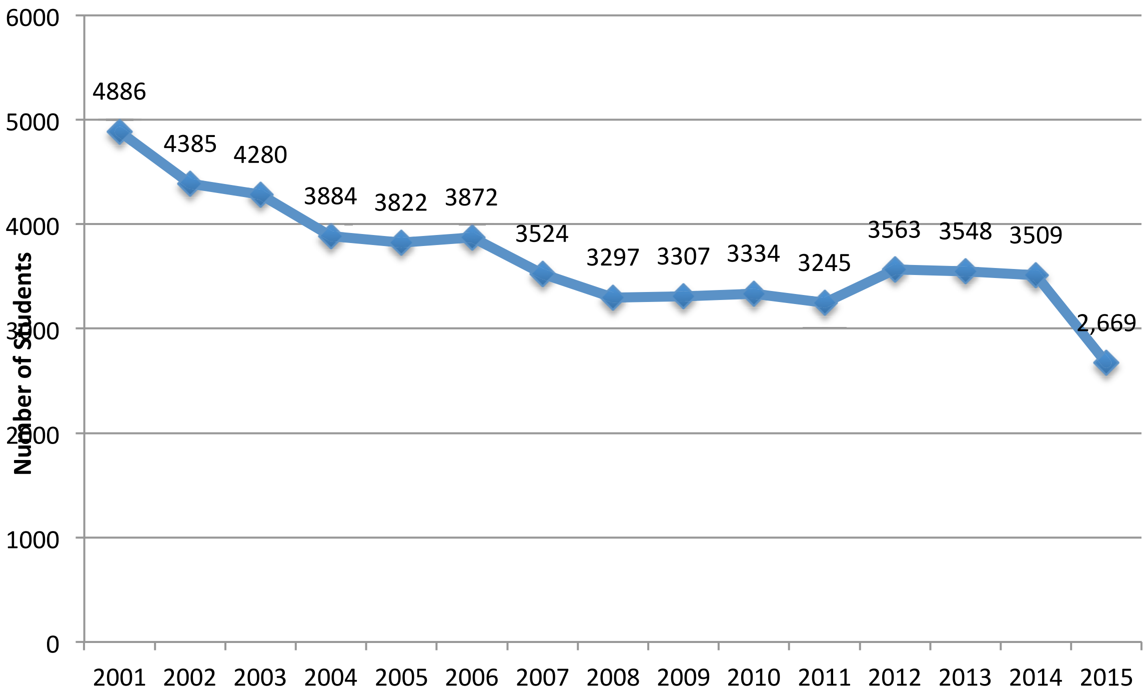
- Identify a question that can be answered through scientific investigation
- Design and conduct a scientific investigation
  - Research topic
  - Record all data in log book
- Use appropriate mathematics, tools and techniques to gather data and information
- Analyze and interpret data
- Develop descriptions, models, explanations and predications
- Think critically and logically to connect evidence and explanations
- Recognize and analyze alternative explanations and predications
- Write up findings in a research report
- Display findings on a display board with report and log book

Source: June 2015

http://static1.squarespace.com/static/545d32b5e4b0719cb5aae580/t/54c27e3ae4b07ef54525c635/1422032442349/SSD+standards.pdf

APPENDIX D - TOTAL NUMBER OF STUDENTS PARTICIPATING IN ALL 17

OHIO DISTRICT SCIENCE DAYS BY YEAR



Source: The Ohio Academy of Science (OAS 2015)