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A Case Study: Motivational Attributes of 4-H participants engaged in Robotics

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A case study: Motivational attributes of 4-H participants engaged in robotics

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Robotics has gained a great deal of popularity across the United States as a means to engage youth in science, technology, engineering, and math. Understanding what motivates youth and adults to participate in a robotics project is critical to understanding how to engage others. By developing a robotics program built on a proper understanding of the motivational influences, the program can be built on a foundation that addresses these influences. By engaging more youth in the robotics program, they will be able to envision a future for themselves as a high-school or college graduate, in addition to a viable employee with marketable skills in tough economy.

The purpose of this research was to evaluate the underlying motivational attributes or factors that influenced 4-H youth, parents, volunteers, and agents to participate in the Mississippi 4-H robotics project. Specifically, this research focuses on two unique counties in Mississippi with very diverse populations. Interviews with participants, observation, and document analysis which took place occurred over the course of a robotics year – October to July. This study sought to identify motivational attributes of participants in the robotics project. Once identified these attributes could be used when developing new program curricula or expanding into new counties in Mississippi.

Data analysis revealed that there are many unique motivational factors that influence participants. Among these factors, (1) the desire to build and construct a robot, (2) competition and recognition, (3) desire for future success and security, (4) safe place to participate and build relationships, (5) teamwork, (6) positive role models, and (7) encouragement.
Key words: robotics, 4-H, intrinsic motivation, extrinsic motivation, informal learning.

DEDICATION

I would like to dedicate this research to my parents; David and Jeannine Smith, and to my brother, Kerry Smith. Family truly is the backbone of the dissertation process. Without their constant love, understanding, and encouragement this endeavor would have been short-lived."

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TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

CHAPTER I

INTRODUCTION TO THE STUDY

Introduction

According to *Forum Focus: Can America Globalize Itself?* (2006)*,* the United States is considered to have the most educated workforce in the world, but with the pending retirement of the baby boomers—considered the best educated segment in the American workforce—it is an uncertain future that awaits the United States in the face of a competitive, global economy. As the baby boomer generation pauses to take a collective look backward at their great-grandchildren's generation, what they see is a generation of American youth ill-equipped to succeed in the global economy (Symonds, Schwartz, & Ferguson, 2011).

Equipping these youth to succeed in the global economy is a difficult task. Current research (Alimisis, Moro, Javier, Frangou, & Papanikolaou, 2007; Atmatzidouw, Markelis & Demetriadis, 2008; Barker & Ansorge, 2007; Bers, 2008; Church, Ford, Petova, & Rogers, 2010; Druin & Hendler, 2000; Mauch, 2000; and Zadok, 2009) Preparing the Next Generation of Stem Innovators (National Science Foundation, 2010) suggests that robotics can be an effective tool to both engage and equip youth.

According to a report entitled *Preparing the Next Generation of STEM Innovators: Identifying and Developing Our Nations' Human Capital* (National Science Foundation, 2010), "Engineering is a field critical to innovation, and exposure to engineering activities (e.g., robotics and invention competitions) can spark further interest in STEM. However, exposure to engineering at the pre-collegiate level is exceedingly rare" (p. 26). Robotics is a term that can mean many different things to different people. In this study, robotics is the term chosen to define a set of building and computer programming activities that can be structured to build the student's knowledge from beginner to advanced engineer programmer.

Carnegie-Mellon University and the National Robotics Academy at Carnegie-Mellon have historically been at the forefront of robotics education. They have been instrumental in developing programming languages young students can understand as well as providing virtual worlds for youth to practice programming skills. A current research focus for the National Robotics Academy is the implementation of a badge system to determine whether or not badges have the ability to impact student's motivational levels (Higashi, Abromovich, Shoop, & Schunn, 2012). According to a recent article, *Are Badges Useful in Education?: It Depends Upon the Type of Badge and Type of Learner,*

> Badges, much like their counterparts in scouting and videogames, are seen as a way to assess learning outside of formal schooling. The issuers of educational badges—an educator or educational organization—can give a symbolic award for any type of skill, knowledge, or achievement similar to how they current provide degrees or certificates. The symbol, in the form of a badge, can then be displayed by the learner to let others know of their mastery or knowledge. (Schunn, Abramovich, & Higashi, 2012, p .2)

Their research highlights the growing interest educators have in understanding the motivational factors of youth who participate in robotics.

Current Situation of STEM Education in America

According to the State Educational Technology Director's Association, only 7% of college students enter science, technology, engineering, or mathematics STEM degree programs, and of the 7% that enter, only 3% finish their freshmen year in the same program (Jones, 2008). According to the report, *Forum Focus* (2006), only 17% of undergraduate degrees were in science- or engineering-related careers in 2000 whereas jobs requiring science, engineering, and technology have increased 51%. Jones (2008) stated the following:

> Students need an education with a solid foundation in STEM areas so that they are prepared to both work and live in the 21st Century. Since the 1960's, the demand for skills has changed significantly–the demand for routine manual task skills have decreased, while the demand for non-routine interactive task skills have increased significantly. Workforce projections for 2014 by the U.S. Department of Labor show that 15 of the 20 fastest growing occupations require significant science or mathematics training to successfully compete for a job. (p. 2)

Barker (2008) reported, "In the 2005 National Assessment of Educational Progress (NAEP) report, only two percent of American students' attained advanced levels of science or mathematics achievement by Grade 12. Moreover, a substantial percentage of students also scored below the "basic" level of proficiency in science and mathematics" (p. 9).

The *Forum Focus* (2006) report found an interesting statistic that if the college maturation rate stays flat over the next 15 years "the country as a whole would experience a two-percent drop in personal income, which would be a 'huge shock to the country, [a] blow to the standard of living' " (p. 14). The American economy relies on technology and the jobs associated with it. However, American youth continue to fall further and further behind their counterparts in other countries in the areas of science, technology, engineering, and mathematics. It is estimated that 29% of K–5 teachers in America teach science less than two days a week (Jones, 2008). If children are not exposed to STEM at an early age they are more likely to think that STEM studies and careers is not for them. The Afterschool Alliance (2009) reported that American children show little motivation or interest in STEM related subjects, especially during the traditional school day.

This could have a devastating impact for Mississippi, which falls behind the rest of the country in both education and access to technology. According to the Progressive Policy Institute (2010) report entitled *The State New Economy Index*, only 17% of Mississippians have access to the Internet, which puts Mississippi last in the nation. According to the researchers, the results are unsurprising, as the Midwest, Plains and the South have economies rooted firmly in agriculture with very low rates of entrepreneurship (Atkinson, & Andes, 2010). *Bringing Broadband to Rural Mississippi Appalachia* (2005), a report commissioned by the John C. Stennis Institute of Government, found that "while 99% of public schools have Internet access and over 90% have high speed Internet access, 47.7% of the students who attend those schools go home to a residence without Internet access" (Hardwick, et al., 2010, p. 6). However, lack of access is not the only barrier to students pursuing STEM related subjects. Kress (2008) argued that parents today do not have a proper understanding of the importance of science, technology, and math skills to encourage their children in those studies. As such, it becomes an ingrained, generational pattern that leads children away from careers that require a working knowledge of those subjects (Gottfried, Marcoulides, Gottfried, & Oliver, 2009). A report produced by the State Workforce Investment Board (2010) found that "17% of working age Mississippians have a bachelor's degree or higher" (p. 26) out of a total possible workforce of 1.3 million Mississippians. However, 27% of Mississippians age 25 and older do not have a high school diploma, which significantly impacts their ability to find work, considering only 20% of all jobs in the United States require less than a high school diploma. The report further stated:

> Mississippi must undergo a cultural learning transformation. High school graduation must be valued more. There must be a new respect and awareness of technical education and education in the skilled crafts. Life-long learning must be embraced and supported. We must move from a culture that is comfortable with poverty to a culture that is not afraid to learn and change to be part of the world of work. (State Workforce Investment Board, 2010, p. 8)

4-H as a Pathway for Life-Long Learning Outside the Classroom

It is in this vacuum that the 4-H youth organization in Mississippi has chosen to engage the youth of Mississippi and to respond to the national concern for improving the American workforce by engaging youth in STEM project work. Over a century ago, the MSU Extension Service, in conjunction with a newly formed youth movement called 4-

H, was called upon to teach rural Mississippi farmers out of near poverty (Wessel & Wessel, 1982). At the time the Extension system was created, more than 50% of Americans lived in rural areas and over 30% of the American workforce was employed in agriculture-related fields (United States Department of Agriculture, 2011). By engaging rural youth with new, innovative farming methods, surrounding farmers could see the benefit of implementing these new methods first hand.

From a cotton-based economy, farmers saw their young sons planting a new crop. This new cash crop was corn, and it would radically change the dietary and economic framework of rural Mississippi. These youth took seeds furnished by what was then Mississippi State College and learned from agriculture specialists the best way to grow this new crop. Corn not only produced higher yields, resulting in the farmer getting more cash for his crop, but it also provided a much needed boost to the rural diet (Wessel & Wessel, 1982). By reaching rural Mississippi youth, 4-H and the Extension Service changed a generation and altered the agricultural landscape in Mississippi.

A century later, the agricultural landscape of the United States is much altered. According to a 2005 report by Dimitri, Effland, and Conklin (2005),

> As part of the transformation spurred by technological innovation and changing market conditions, production agriculture has become a smaller player in the national and rural economies. While the more broadly defined food and agriculture sector continues to play a strong role in the national economy, farming has progressively contributed a smaller share of gross domestic product (GDP) and employed a smaller share of the labor force over the course of the century. (p. 29)

To further highlight this shift in the American landscape, 2% of the American workforce was engaged in farming-related areas in 2000, compared to 16% as the country came out of World War II (Dimitri et al., 2005). At the turn of the century, 41%, or nearly half of the county, was engaged in agriculture (Dimitri et al., 2005). Although there is a national decline in agricultural-related jobs, Mississippi's economy is still heavily dependent on agriculture with one out of every four jobs in Mississippi related to agriculture (Mississippi Farm Bureau, 2007).

4-H, as one of the largest youth organizations in Mississippi and the Extension Service, as the educational outreach arm of MSU, are being called upon once more to provide the tools necessary for a new generation of Mississippi youth to define their future. Even as corn changed the agricultural landscape of Mississippi 100 years ago, technology stands poised to transform Mississippi again. With respect to the agricultural heritage that has provided the framework for past success, youth must be prepared to pursue careers in science, technology, engineering, and math. As stated previously, the numbers tell the stark reality. Mississippi youth are ill equipped to compete in today's global economy. Just as their ancestors did over 100 years ago, youth must once again fuel the change for educational and economic growth. However, schools alone are not capable of meeting the demand (Druin & Hendler, 2008; Jamison, 2008).

Robotics as a Pathway to Future Careers in STEM

With the vast array of potential technologies available to teachers, it is often difficult to sort through all of the possibilities and find one that is affordable, scalable, and interactive. Some schools have decided that the LEGO® Robotics Mindstorm Kit is, while expensive, an appropriate solution. These kits, which cost $345.00, are durable and can be reused numerous times for various activities. The kits offer scalability in that they can be scaled down to meet the educational needs of younger students and scaled up in order to engage older students with higher level critical thinking skills. According to the report *Robots for Kids: Exploring New Technologies for Learning* (Druin & Hendler, 2000),

> One of the few types of instructional materials that can be used to support learners of all age and ability groups is robotics. Robotics materials offer a unique alternative to text-based materials because the same set of robotic materials can be used to create very different instructional experiences for students within the same class. That is, robotics can be used to create instructional (and assessment) experiences that are academically rigorous for some students, while for others they can be adapted to provide the structure and support. (p. 172)

Robotics allows students to interact with not only the robot but the programming language, the real-world problem, and their classmates to construct a new frame of reference. 4-H agents work closely with their local schools to provide in-school and after-school experiential programming to augment youth development. Introducing youth to robotics through their local 4-H programs enables children to engage in science, engineering, and technology activities in a relaxed, informal environment. The focus of this study is to investigate the motivational attributes of 4-H youth engaged in the robotics program in Mississippi and that of their 4-H agents, volunteers, and stakeholders.

Background of the Problem

MSU is the largest land-grant institution in the state of Mississippi and is one of the 103 land-grant institutions in the United States. Originally named the Agriculture and Mechanical College of the State of Mississippi, MSU was founded by the Morrill Act of 1862 with the express mission to offer training in "agriculture, horticulture, and the mechanical arts" (p.1; http://msucares.com/about_msucares/morrill.html). The Second Morrill Act of 1890 created land-grant institutions for African Americans as they were not permitted to attend the 1862 land-grant universities; Alcorn State University is the 1890 land-grant institution in Mississippi. Land-grant institutions have three core components: teaching, research, and service.

It is the research and service mission that separate land-grant universities from other universities in the nation (U.S. Department of Agriculture, 2011). The Extension system was created by Congress under the Smith-Lever Act of 1914. The Smith-Lever Act was designed to bring applicable farming practices to rural Americans based on research conducted at the land-grant universities and to provide demonstrations of "existing or improved practices or technologies in agriculture" (p.1; http://msucares.com/about_msucares/smithlever.html). Although the original overarching concept of the 1862 universities focused on bringing the resources and technology of the university to the people, it failed miserably in the southern United States. According to Wessel and Wessel (1982), "Throughout the South local leaders were discovering that farmers generally were reluctant to try new methods. The fastest way to introduce advanced farming methods was through young people" (p. 12). With the passage of the Smith-Lever Act came the creation of a youth organization that would eventually become known as 4-H. According to Wessel and Wessel (1982),

> Although the Smith-Lever Act did not specifically mention youth work, it was understood that the work of rural school superintendents, concerned college agriculture scientists and federal employees in the Office of Farmers' Cooperative Demonstration Work had individually and collectively made youth work the foundation for successful Extension endeavors. (p. 24)

This joint effort became the model for the national 4-H youth movement. Although rural farmers were reluctant to try new practices, Superintendent of Holmes County (Mississippi) Schools, William "Corn Cob" Smith, had a vision for transforming the South from a one-crop agriculture system (Wessel & Wessel, 1982). Smith began a corn contest for young boys in an effort to tie formal education to the rural experiences of his students and to create more interest in the schools among county farmers. Smith hoped that the corn contest would begin to erode the one-crop agriculture of the region. Southern agriculture had suffered since the Civil War's end from over-cropped land and reliance on a single cash crop. A pernicious system of sharecropping and dependence on a local general store for nearly all the farmers' needs nourished a system of agriculture barely one step removed from the peasantry. Smith knew such an agriculture economy could not be expected to support schools at a reasonable level (Wessel & Wessel, 1982). The corn seed was provided by what was then Mississippi State College and the college of agriculture provided information on best farming practices to the 120 young men who accepted the challenge to farm corn on a half-acre plot of land. The results of the first corn club came in October of the first year when youth submitted the results of their work at the local county fair; the corn club had been a resounding success. On hand to witness this success was A. F. Meharg, a demonstration agent for the General Education Board, which was the philanthropic arm of the Standard Oil Company, which brought the work of Smith to the attention of the United States Department of Agriculture. This partnership formed the basis of a national movement known as 4-H.

Although other states had participated in corn growing contests, Mississippi was the first state to merge the resources of the land-grant institution with local community efforts directed at educating youth. "Learning by doing" became the motto for all 4-H club work. In the earliest years of the movement, agents and leaders emphasized the educational value that young people derived from applying new methods to farming and home economics. Classroom instruction was never neglected, but it was understood that at some point the young man or woman would have to do the work and be responsible for the results (Wessel & Wessel, 1982). Being responsible for their work is an important aspect of 4-H work and is rooted in the learning theory of experiential learning.

Influence of Experiential Learning in 4-H

Experiential learning is a learning theory that is rooted in the concept that the learner makes meaning of his or her environment by actively participating in it. The roots of experiential learning can be found in the Chinese philosopher Confucius, who said, "I hear and I forget. I see and I remember. I do and I understand" (Leach & Paulsen, 1999, p. 118). It was American philosopher John Dewey who brought experiential learning into the educational mainstream in the early 1900s. Experiential learning is a cornerstone of 4-H programming. In the 4-H model, youth form small groups or clubs based around a project. In 2009, the federally mandated ES-237 report revealed that 104,622 youth engaged in 142,062 projects ranging from the traditional—livestock, shooting sports, home management—to the more modern—photography, electricity, and computer. A typical project would include a hands-on activity (experience) followed by discussion (share) among the group members or with knowledgeable volunteers and then some form of reflection (process; usually in reflective writing). The project is always tied to a real-life situation and real-life careers (generalization) that youth could investigate further if they were so inclined; youth are asked to teach others (apply) what they have discovered. Diem (2001) of the Cooperative Extension Service at Rutgers Univeristy stated that,

> The 'learn-by-doing' approach allows youth to experience something with minimal guidance from an adult. Instead of being told 'the answers,' they are presented with a question, problem, situation, or activity which they must make sense of for themselves. (p. 1)

According to Barrows (1996), experiential learning is drawn from the constructivist theory. A major component of constructivist theory is that learning is a dynamic continuum whereby the learner takes new information he or she is presented and incorportates that new information with what he or she already knows to form a new level of understanding. Barrows believes that experiential learning is similar to problem-based learning in that students learn concepts and principles through authentic experiences and problems, learning occurs in small groups, and teachers act as facilitators (Barrows, 1996). The experiential model has five core components: experience, share, process, generalize, and apply. Robotics is uniquely fitted to the experiential model because it requires 4-H'ers to actively engage in the process of learning. They are given the opportunity to work with individual pieces that they can put together to create a robot that responds to their programming commands and even to their voices. According to Chambers, Carbonaro, and Rex (2007),

> Students are given ownership for their learning within an active, enjoyable, and non-threatening environment. They can make choices and solve problems as they meet the challenges that are a natural consequence of robot design. Working with robotics also provides students with an opportunity to construct knowledge through activity and further develop numerous mathematical and scientific concepts. (p. 55)

Beer, Chiel and Drushel (1999) described the concept of ownership this way, "Students often feel that education is something that is done to them, rather than something they are actively doing for themselves because they are not encouraged to think critically" (p. 4). Robotics requires the student to be an active participant in the process and demands that the student think critically about the problem so that he or she can design a robot that best solves the task or problem. This requires a hypothesis, a plan of action, and an execution of that plan. It requires a constant reworking of the hypothesis and the robot.

Developing Critical Thinking Skills Through Robotics

Students find this to be the most difficult aspect of robotics, that there is no one correct answer. Often, they are stymied by the fact that there is not a predetermined series of steps they can take to achieve a "successful" result. Beer (1999) stated, "Current educational practices encourage passive listening in large lectures rather than active engagement. It encourages finding the single answer that the professor wants, rather than creatively exploring multiple possibilities" (p. 4). It is the "multiple possibilities" that often prove frustrating for young learners as they have not developed the ability to think critically. Robotics can be used as a tool to help students develop critical thinking skills. According to Druin and Hendler (2000),

> The addition of technology in the classroom has asked us as a society to reexamine our existing educational goals. It has asked us to stop and question what our true hopes may be for our children today and tomorrow. In doing so, we must ask, do our tools support these goals? If they don't, do we change the tools that we have? Do we change the goals we have? Do we change both? (p. 161)

For this generation of children, the Generation Z or digital natives as they are sometimes called, many have never known a world without the Internet, cell phones, laptops, iPods, or Facebook—their very essence is defined by the technology they use; it is part of who they are and is formative to their identities.

Using Robotics to Reach Diverse Youth

Generation Z is made up of children who were born after 1990 and are known as the "quiet generation;" they account for 18% of the world's population and are considered the most technology connected. As young children (5–8 years old), Generation Z began with the interactive social network Club Penguin, and once they reached 13 years of age, they graduated to the most popular social network in the world: Facebook. However, only 47.7% of Mississippi youth have access to the internet from home. Many Mississippi youth access the Internet from mobile devices such as smart phones. According to the report *Critical Issue: Using Technology to Improve Student*

Achievement, “16 million youth use instant messaging and 78% use instant messaging to talk about schoolwork” (Learning Point Associates, North Central Regional Educational Laboratory, 2005, p. 3). Conversely, this same technology (text messaging, podcast creation, wiki development) is slow to be integrated into the classroom. However, 53% of public schools teachers who have access to a computer use them for instruction during class. Those teachers from higher income areas report 61% computer usage in the classroom compared to 50% computer usage in lower income schools (Learning Point Associates, North Central Regional Educational Laboratory, 2005). Additionally, the report finds that there is a difference in how technology is used in low-income schools compared to high-income schools. Low-income schools use computers for “traditional memory-based and remedial activities” whereas high-income schools use computers to encourage students toward self expression and communication (Learning Point Associates, North Central Regional Educational Laboratory, 2005). 4-H has the potential to bridge the gap between students who attend high-income schools and those that attend low-income schools. By adopting the hands-on approach to learning, 4-H gives youth of all backgrounds the ability to express themselves and communicate through technology.

Understanding the Theoretical Framework for the 4-H Model

The theoretical framework for the 4-H model rested heavily on the work of philosopher John Dewey. Papert (1980), a student of Dewey’s educational philosophy, believed that John Dewey expressed nostalgia for earlier societies where the child becomes a hunter by real participation and by playful imitation. Learning in our schools today is not significantly participatory—and doing sums is not an imitation of an exciting, recognizable activity of adult life. But writing programs for computer graphics or music and flying a simulated spaceship do share very much with the real activities of adults, even with the kind of adult who could be a hero and a role model for an ambitious child (p. 179).

Typically in the 4-H model, local agents and volunteers provide Dewey's role model for the "ambitious child." 4-H agents oversee multiple projects that the youth in their counties participate in, but due to the sheer volume of 4-H'ers and projects, volunteers play an important role. Volunteers are usually parents, teachers, and civic or church leaders who want to bring additional educational opportunities to the youth of their schools or communities. In Mississippi, there are approximately 7,733 volunteers that invest 1,701,260 hours annually in the youth of their community. Volunteers form an integral part of the 4-H experience providing everything from snacks to mentoring, and as such, the "Land-grant universities have been directed to collect and implement stakeholder input when setting priorities for research, education, and Extension and to be more engaged with their constituents" (Kelsey & Mariger, 2003, para. 31). Volunteers are key to the overall success of a project as they are usually the driving force behind it. If the robotics program hopes to encourage 4-H youth to pursue science, technology, engineering, and mathematics project areas, it must not only capture the interest of the youth, but volunteers must become engaged as well.

Further, to provide meaningful learning opportunities through local robotics club projects, it is imperative to understand what motivates volunteers to go into a completely unfamiliar project for most of them and why they encourage youth to pursue the robotics program—arguably one of the more difficult projects in 4-H. Conducting a study that focuses on the motivational factors that influence participation in STEM-related projects, notably robotics, among Mississippi 4-H youth and the volunteers that influence them can provide an understanding of the phenomenon.

Statement of the Problem

The National 4-H Strategic Directions Team released *The Power of Youth in a Changing World National 4-H Strategic Plan* (2001), which identified two of the organizations' six learning goals as being technology driven. This team was made up of, "youth, volunteers, and youth development professionals, who in turn gathered information from thousands of youth and adults from all over the country" (p. 4). Furthermore, "the answers served as a guide for the Strategic Directions Team to follow and, combined with vital information from the fields of youth development, public policy, and community-based leadership, grew into the National 4-H Strategic Plan" (p. 4).

Goal 3 of the strategic plan stated that "4-H will use new technologies to shape learning opportunities to go beyond boundaries of geography, time, expertise, and leadership" (p. 3). The national team recommends that new technologies be used to deliver existing 4-H activities and events while integrating computer technology to increase educational effectiveness. The fourth identified goal is to use 4-H to promote scientific and technological literacy by increasing scientific content and technology usage in 4-H programming.

An integral mandate of the 4-H program is to provide meaningful learning opportunities and direct access to technology for the more than 100,000 Mississippi youth currently participating in Mississippi 4-H. With the predominance of technology in modern society, it would be easy to presume that engaging Mississippi 4-H'ers in technology-based projects would not be a difficult task. However, out of 142,062 total projects completed by 4-H'ers, only 1,142 were computer related, accounting for 0.008% of all projects (Mississippi Statewide Yearly ES-237 Report, 2009). The national report indicated that computer-related projects accounted for only 57,484 of the roughly 1,370,823 total projects, which accounts for roughly 0.042% of the total projects conducted in 2003 (REEIS Report, 2003). While other, more traditional 4-H projects are growing, technology-related projects continue to fall further behind.

The number of youth enrolled in these project areas shows that less than 1% of Mississippi youth are engaged in technology-related projects (Mississippi Statewide Yearly ES-237 Report, 2009). Many studies (Goldman, Eguchi, & Sklar, 2004; Mataric, Koenig, & Field-Seifer, 2007; Petre & Price, 2004; Rusk, Resnick, Berg, & Pezalla-Granlund, 2008; and Sklar, Eguchi, & Johnson, 2003) have been done on robotics, and all found that robotics is a tool that can be used to motivate youth. The research of Petre and Price and Sklar et al., both looked at the intrinsic motivational factors that affect youth participation in robotics contests, but a majority of the research simply implies that robotics is motivating (Petre & Price, 2004; Sklar, et al., 2003). According to Ruis-del-Solar and Aviles (2004),

> Robotics is a highly motivating activity for children. It allows them to approach technology both amusingly and intuitively, while discovering the underlying science principles. Indeed, robotics has emerged as a useful tool in education since, unlike many others, it provides the place where fields of science and technology intersect and overlap. (p. 6)

Understanding what makes robotics “highly motivating” is important, particularly as it pertains to Mississippi youth. Motivation is a key determinant in whether or not youth pursue certain 4-H project areas. According to Ryan and Deci (2001), “To be motivated means to be moved to do something. A person who feels no impetus or inspiration to act is thus characterized as unmotivated, whereas someone who is energized or activated toward an end is considered motivated” (p. 1). Barker and Ansorge (2007) stated,

> Studies show that robotics generates a high degree of student interest and engagement and promotes interest in math and science careers. The robotics platform also promotes learning of scientific and mathematic principles through experimentation, encourages problem solving and promotes cooperative learning. (p. 9)

The lack of participation in technology-related 4-H project areas, notably robotics, amongst Mississippi 4-H youth is a troubling trend given the current focus on better preparing American youth to pursue careers in the sciences. In 2009, Mississippi 4-H conducted a pilot robotics program to assess the possibility of implementing a permanent statewide robotics program. Overall, the pilot year was a success. However, many interesting issues arose from the pilot year. One dichotomy that was of particular interest occurred during the pilot year of the robotics’ contest. The first-place team came from a very influential school with abundant resources, and their volunteers were actively engaged in the process of the robotic build and contest. The second-place team came from a school district that has the second highest dropout rate in the state of Mississippi. Their volunteers had no procedural knowledge of either engineering or programming but stayed with the youth the entire time, encouraging them to solve problems and to think problems through to a resolution. In 2010, a homeschooling group joined the robotics program, winning first place in the statewide competition. All three groups came from vastly different cultural and socioeconomic backgrounds, yet all share in the pursuit of competing in the robotics challenge. The problem this research addressed was identifying the unknown motivational factors that influence 4-H agents, volunteers, and youth from different socioeconomic strata to engage in the robotics project.

Purpose of the Study

The purpose of this study is to examine the underlying factors that influence motivation amongst 4-H youth, 4-H agents, and volunteers engaged in the robotics program. This study is necessary due to the lack of participation in STEM projects and the potential for robotics to serve as a "pipeline" that engages 4-H youth and then directs them into other STEM-related projects. The term "pipeline" is used in educational research to describe the process by which students begin as young learners in elementary school and over time leave the educational system that carries them into careers in STEM-related areas. Motivation plays a key role in the engagement level of youth in robotics, but how is unknown. Learning is more than rote memorization, it is inherently linked to the student's motivational beliefs "to the extent that students develop adaptive motivational beliefs, [so] they are more likely to seek out challenges, take risks, persist in the face of difficulty, and ultimately demonstrate higher levels of achievement" (Beghetto, 2004, para. 1). Examining two distinct groups from varying socioeconomic backgrounds can offer culturally relevant information on what motivates these participants. By gaining an understanding of student's motivational beliefs, it will be possible to better understand how students learn. Understanding how students learn will impact youth programming, curriculum development, and project delivery.

Research Questions

The following research questions guided the study and provided manageable parameters for this research. Each of the five questions listed below contain sub questions to further engage the participant and gain a holistic understanding of what factors influence participants to engage in robotics. The questions originate both from the literature review and from issues of interest that arose from the robotics pilot year.

1. Are 4-H youth intrinsically or extrinsically motivated to participate in robotics?
2. What motivates volunteers to help 4-H youth participate in robotics projects?
3. Are the factors that motivate 4-H boys different than those that motivate 4-H girls?
4. What role if any does ethnicity play in the motivational attributes of 4-H'ers, volunteers, agents, and administrators?
5. What is the role of varying factors of motivation in success? What does "success" in the robotics project mean for the youth, agents, volunteers, and stakeholders?
6. What role do administrators have in promoting robotics, and how are those efforts perceived by youth, volunteers, and staff at the county level?

These questions sought to engage participants and present them with an opportunity to share responses and stories so that the 4-H youth, agents, volunteers, and administrators, had the opportunity to voice their vision. Today, the youth of Mississippi face a new challenge—to transition from the rich agricultural history to a technology-driven workplace.

However, in order to facilitate the transition, the intrinsic and extrinsic motivational factors that bring participants to robotics must be understood. The first research question seeks to identify characteristics of the participants' narrative that are uniquely intrinsic or extrinsically motivated. According to Ryan and Deci (2000), "The most basic distinction is between intrinsic motivation, which refers to doing something because it is inherently interesting or enjoyable, and extrinsic motivation, which refers to doing something because it leads to a separable outcome" (p. 2). Further, the authors give credence to the need to identify the "factors and forces" that influence participants: "because intrinsic motivation results in high-quality learning and creativity, it is especially important to detail the factors and forces that engender versus undermine it" (p. 2). Conversely,

> Students can perform extrinsically motivated actions with resentment, resistance, and disinterest or, alternatively, with an attitude of willingness that reflects an inner acceptance of the value or utility of a task. In the former case—the classic case of extrinsic motivation—one feels externally propelled into action; in the latter case, the extrinsic goal is self-endorsed and thus adopted with a sense of volition. (p. 2)

Both intrinsic and extrinsic factors contribute to an understanding of motivation theory that arises out of the behavioral theories of learning. Robotics brings together two diverse theories; constructionism, which is birthed from constructivism, and motivational theory, which as stated previously arises from behavioral theory. The second question addresses 4-H agents and volunteers. Without a commitment of time, energy, and resources by agents, volunteers, and stakeholders there can be no future for the robotics program in Mississippi. These individuals are the vehicle for exposure. They bear the primary responsibility for arranging meeting times, working with local schools and churches, securing resources for supplies, transporting children to and from club meetings, and serving as the primary facilitator during robotics club meetings.

Gender inequality in STEM-related areas has been well documented. However, the third question will examine factors that motivate girls to pursue robotics specifically. According to Fancsali (2003),

> Research indicates that gender differences in performance are related to "common, ordinary difference" in the mathematics and science education of girls and boys (e.g., sex-role stereotyping about mathematics and science skills)—differences that contribute to "different interests, attitudes, achievements, and enrollments during junior and senior high school" (Kahle, 1996 as cited in Fancsali, 2003). These differences can have serious ramifications for girls in terms of their postsecondary education and career choices. (p. 2)

Ethnicity is not an issue that is addressed very much in the robotics literature but the robotics pilot year indicated that it might be a question that would yield important findings. In the first year of competition the first-place team was an all-Caucasian team from an affluent county whereas the second-place team was an all-African-American team from a much poorer county.

The fifth question addresses how the participants define success. What does it mean for participants to be successful? Measuring success is an easy thing to do if the expectations and benchmarks are already set. In the absence of such benchmarks, it is necessary to discover participant's views on success.

The sixth and final question seeks to identify the role of administration in promoting robotics. In a downward economic cycle, what motivates administrators to place an emphasis on robotics? Due to the high cost of robotics as related to other projects identifying the gains associated with robotics is necessary in continuing the program.

Qualitative Research Design

This study will be conducted within the qualitative research framework. By utilizing qualitative principles, the researcher will be able to take a recognized phenomenon (in this case, 4-H youth, agents, and volunteers that show interest in the robotics project) and develop an understanding of the construct in which participants engage in the robotics program. According to Patterson (1990),

> The task for the qualitative researcher is to provide a framework within which people can respond in a way that represents accurately and thoroughly their points of view about the world, or that part of the world about which they are talking—for example, their experiences with a particular program being evaluated. (p. 21)

In this study, a variety of data collection methods were used to explore the issue. These inquiry methods included interviews with study participants, observation, and surveys.

Currently, there is not enough substantial research to generate a quantifiable questionnaire or survey regarding motivational factors influencing 4-H youth in the field of robotics Moreover, this specific population, 4-H youth engaged in science, engineering, and technology activities, have not been researched thoroughly enough to generate common factors that identify them as a subgroup of the larger population. A qualitative case study provides the best method by which to assess the issue. According to Merriam (2009),

> Anchored in real-life situations, the case study results in a rich and holistic account of a phenomenon. It offers insights and illuminates meanings that expand its readers' experiences. These insights can be construed as tentative hypothesis that help structure future research; hence, case study plays an important role in advancing a field's knowledge base. (p. 51)

This research will utilize a descriptive case study methodology, for it aptly fits with the "newness" of the robotics program in 4-H. Merriam (1991) wrote that descriptive case studies are useful "in presenting basic information about areas of education where little research has been conducted. Innovative programs and practices are often the focus of descriptive case studies in education. Such studies often form a database for future comparison and theory building" (p. 27). By conducting a qualitative case study on this subgroup and its engagement in robotics, it is hoped that common factors may emerge that lend themselves to the development of a working hypothesis that is grounded in the empirical world. Once common factors influencing motivation and achievement are identified among Mississippi 4-H youth, other states with similar programs may benefit from what is discovered in Mississippi and use the findings to augment or even "jump-start" robotics work in their states. Ames (1992) noted that qualitative research is especially beneficial when assessing motivation of participants: "A qualitative approach to student motivation is concerned with how students think about themselves in relation to learning activities and to the process of learning itself" (p. 261).

Further, qualitative research has a long tradition of providing rich, descriptive, raw data in the form of direct quotations. Patterson (2002) stated that direct quotations reveal the respondents' "depth of emotion, the ways they have organized their world, their thoughts about what is happening, their experiences, and their basic perceptions" (p. 21). This method of data collection is particularly useful when working with youth. Current research (Trolley & Hanel, 2009) showed that youth today live in a version of reality known as cyber-reality. Today's youth have never known a world without reality television, Facebook, YouTube, and so forth. For these youth, it is a natural extension of who they are; they post their "status" for the world to see, "tweet" about the mundane happenings of their day, and post videos taken with their cell phones to YouTube. Qualitative research with its emphasis on observing the subject in their natural environment is the ideal research tool to identify factors that influence motivation and achievement.

Significance of the Study

The research available on robotics focuses primarily on students in a laboratory-type environment or students engaged in robotics competition (Lund & Pagliarini, 2000; Skylar et al., 2003). As stated previously, a large portion of the literature stated that robotics is motivating due to its inherent nature as a constructible toy that allows children the freedom to work in a hands-on environment (Bers, Ponte, Juelich, Viera, & Schenker, 2002; Bers & Urrea, 2000; Papert, 1980; Petre & Price, 2004). Not present in the research is an in-depth analysis of what motivates Mississippi, or other states' youth, to participate in robotics. Also missing from the research is an investigation into the motivational factors that inspire parents, agents, and volunteers to follow their 4-H'ers into the unknown world of robotics, a place that is both unconventional and difficult. Further, by understanding the motivational attributes of 4-H youth engaged in robotics, other rural communities may benefit. This study is significant because it will investigate what motivates this diverse group of Mississippi youth and adults to participate in robotics.

Limitations of the Study

One limitation of this study is that the results of the study are only transferable to other 4-H departments in the nation (There are 50 such organizations in the nation, not including the Indian reservations and overseas 4-H programs, as well as military 4-H programs). Further, Merriam (2009) stated that "qualitative case studies are limited, too, by the sensitivity and integrity of the investigator. The researcher is the primary instrument of data collection and analysis" (p. 52).

Definition of Terms

4-H: 4-H is a national youth organization funded by the United States Department of Agriculture. Every county in every state in the United States maintains a 4-H presence. The organization involves youth in more than 80 countries in topic-specific project work.

Mississippi State University Extension Service: The MSU Extension Service operates as the "extension" of MSU. As a land-grant institution, MSU is required to bring the research of the university to the people of Mississippi. The Extension Service maintains an office in all 82 counties in Mississippi and handles annually millions of requests for information in addition to providing educational programming.

Morrill Act: The Morrill Act of 1862 provided for the land-grant system to begin in each state to provide the states' populous with access to researched-based education at the local level. The Morrill Act of 1890 provided for African Americans to attend land-grant institutions. Mississippi and Kentucky were the only states to create separate land-grant institutions. MSU is the 1862 institution whereas Alcorn State University is the 1890 land-grant institution in Mississippi.

Smith–Lever Act: The Smith–Lever Act of 1914 created what at that time was called the Cooperative Extension Service. The Extension Service provides research-based programming to local counties.

Extrinsic Motivation: according to Ryan and Deci (2000) "is a construct that pertains whenever an activity is done in order to attain some separable outcome" (p. 2).

Intrinsic motivation: Ryan and Deci (2000) described intrinsic motivation as "intrinsically motivated behaviors, which are performed out of interest and satisfy the innate psychological needs for competence and autonomy are the prototype of self-determined behavior" (p. 65).

Summary

The ensuing chapters contain a detailed review of the literature, the methodology used to conduct the study, findings from the study, a summation of those findings and recommendations for further research that were identified during the course of this research. The review of literature covers the historical span of the 4-H movement, and it dovetails into the American philosophical and pedagogical theories that gave rise to the robotics movement. Further, it investigates the motivational theories that impact learning and how motivation plays an important role in determining student's perceptions of

STEM project areas. In the methodology section, a precise outline of the procedures and methods used in this study are outlined so that other researchers may follow behind the study. The methodology includes the following: design of the research, the context of the research, participant selection and overview of participant characteristics, data-collection methods, analysis of acquired data, issues of rigor, credibility, triangulation and member checks, dependability and audit trail, transferability of results and the rich, thick description associated with qualitative research. In the results section, the analysis of the data will be presented from information gathered by participants. The conclusion will draw from the findings that surface in the results while the summary will identify what factors that influence motivation in 4-H youth. Finally, the recommendations will offer insight on motivating other Mississippi youth to pursue robotics.

CHAPTER II

REVIEW OF THE LITERATURE

Introduction

A review of the literature revealed a great deal of research on motivation, stemming from the behavioralist learning theories and the subsequent theoretical development of social-cognitivism. Conversely, there was some research on the use of robotics in the educational environment but written from the constructivist approach. As the literature reveals, using robots in the educational environment does motivate students, but there is little research as to the factors that influence that motivation and the impact of that motivation in their success. According to the book, *Robots for Children* (Druin & Hendler, 2000),

> Robots ranks right up there with dinosaurs when it comes to grabbing the attention of elementary school students, as previously discussed, robots are an excellent mode of teaching many content areas. Robots are also exceptionally effective at influencing attitudes, not just toward science and math but also toward career paths in technology and engineering. And when it comes to affecting lifelong attitudes, it's well known that the earlier you start, the more powerful the impact. (p. 232)

However, there is little research on using robotics in an informal educational setting like 4-H (Barker, 2007; Barker & Ansorge, 2007; Bourdeau & Taylor, 2007; Elmore & Seiler, 2007; Fancsali, 2003). The objective of the following review of literature focuses on the progression of educational robotics into informal learning environments and the role of motivation in prompting students to pursue robotics.

Robotics – Building Blocks for the Mind

LEGO® released the Mindstorm Robotics Invention Kit in 1998 to the general public; by 1999, sales of the robotics kit had risen 300% (Mindell, 2000). The Mindstorm Robot began as a project in the Massachusetts Institute for Technology Media Lab and was based on the work of researchers Seymour Papert and Mitchel Resnick. Papert believed that "training in computer programming might be one of the most promising ways to teach children about the nature of problem solving" (Rothstein, 1999; as cited in Mindell, 2000, p. 4). Papert had written his seminal work entitled *Mindstorms* (1980) for which the robot was named. Papert worked with Jean Piaget in the 1960s and took from Piaget the idea that children could build their own intellectual structures. It was also at this time that Papert developed the Logo software, which was a programming language for children (Mindell, 2000). According to Papert (1980), children can learn a great deal without being formally taught:

> I take from Jean Piaget a model of children as builders of their own intellectual structures. Children seem to be innately gifted learners, acquiring long before they go to school a vast quantity of knowledge by a process I call "Piagetian learning," or "learning without being taught." (p. 7)

For Papert, robotics proved the perfect mindtool for children because they could take small physical objects (in this case LEGOs®) and create an actual object—the object becomes a physical manifestation of the inner workings of their young minds. Although the majority of the components in a LEGO® system are rectangular bricks, elements such as wheels, axles, pulleys, and gears can be combined to create objects that demonstrate specific concepts and incorporate mobility into the object(s) created.

Programming Plastic Bricks

The base NXT robotics kit contains three servo motors, an NXT intelligent brick, an ultrasonic sensor, a light sensor, a touch sensor, and a sound sensor, as well hundreds of specialized LEGO® pieces. The NXT "grey" kit, as it is often referred to, costs approximately $279.00. Most of the more detailed, complicated robots require more parts and thus the "blue" LEGO® educational kits are used in addition to the base kit. This kit includes 672 pieces and costs around $119.00.

While the multitude of shiny, plastic construction blocks often proves appealing to children, it is the NXT Intelligent brick, or "mind" of the robot, that students can program to perform specific tasks. According to the book, *Robots for Children* (Druin & Hendler, 2008),

> Robots make the need for computer programming obvious. You've got a machine sitting on your desk. If you want it to do something, then you need to tell it how to do that from step one. Programming is the way to instruct a robot. (p. 234)

Papert (1980) argues that most educational exchanges are passive in nature with the child listening to the parent's or teacher's explanation. Papert (1980) compares educational television with robotics programming and says that,

> Even the best of educational television is limited to offering quantitative improvements in the kinds of learning that existed without it. "Sesame Street" might offer better and more engaging explanations than a child can get from some parents or nursery school teachers, but the child is still in the position of listening to explanations. By contrast when a child learns to program, the process of learning is transformed. It becomes more active and self-directed. In particular, the knowledge is acquired for a recognizable personal purpose. The child does something with it. The new knowldege is a source of power and is experienced as such from the moment it begins to form in the child's mind. (p. 20-21)

Programming Robots to Move

To perform the tasks, the robot must be programmed using the on-board programming commands, the LEGO® NXT Mindstorm programming software, or C programming. The on-board programming is limited in its functionality, and the C programming is far too advanced for novice beginners. That leaves the object-oriented programming language created by LEGO®, which was mirrored after Papert's earlier Logo software program.

This programming language is a logic-based program that uses drag-and-drop blocks to represent programming commands that control the robot. With these blocks, young programmers can control motors, rotation, speed, as well as sensors and can set command loops to avoid redundant programming.

Mauch (2000) found that,

> Students remain highly engaged throughout the process because they visualize their robot as a toy. The robot becomes much more than a toy, however, as students gradually learn how to control the robot and command it to perform specific tasks. (p. 7)

Users must purchase the NXT programming software in addition to the robotics kits. The software costs approximately $79.00. The LEGO® software gives students of all abilities the opportunity to learn design and programming principles through animated practice and realization. According to the book *Robots for Kids* (Druin & Hendler, 2008),

> The ability to focus on the logic of the program, rather than on the programming language, allows students of varying abilities to demonstrate logical thought in much the same way that eleminating textual demands allows individuals who are unable to independently manipulate written text to demonstrate content knowledge. (p. 184)

The expense of the robotics kits and software combined is not a negligible amount; to get a team started costs nearly $500.00. While some would consider this simply an "expensive toy," Lindh and Holgersson (2007) believed that "Due to their programmability and transparency, robots and programmable bricks are among digital toys that today offer specially interesting features" (p. 1099). These toys, in advanced forms, can be given certain characteristics, such as agency and identity, that make them behave like living entities, challenging our ways of thinking to life, as they position themselves on the boundary of what is animate and inanimate (Turkle, 1995). Their hybrid nature makes it possible to play out the fine line between objectifying minds and animating things (Ackerman, 2000).

Reaching Towards a National Robotics Competition

Three years after the Massachusetts Institute of Technology introduced NXT robotics into the mainstream, inventor Dean Kamen founded the FIRST robotics competition in 1989. The acronym FIRST denotes the title, For Inspiration and Recognition in Science and Technology. Kamen's original vision was to create an atmosphere in which aspiring scientists and engineers could be lauded in the same manner professional athletes are in American culture. "Our culture celebrates one thing: sports heroes," Kamen said, "You have teenagers thinking they're going to make millions as NBA stars when that's not realistic for even 1% of them. Becoming a scientist or an engineer is realistic" (as quoted in Portz, 2002, p. 17).

At the inaugural FIRST robotics competition held in a high-school gymnasium in Manchester, NH, nearly 28 teams competed. In 2011, there was an estimated 2,080 teams representing over 45,000 youth from across the globe. According to an article published in the National Science Teacher's Association entitled "Motivating Students with Robotics," the authors report that "The high school robotics program capitalizes on the student excitement generated by participation in FIRST while providing an avenue for students to increase science-related skills (e.g., critical thinking) and self confidence" (Brand, Collver, & Kasarda, 2008, p. 45).

The competition has grown to incorporate four distinct contests: the Junior LEGO® League (JLL), FIRST LEGO® League, FIRST Techtronics League, and FIRST Robotics Competition. Both the Junior LEGO® League and the FIRST LEGO® League utilize the NXT robotics kit. Competing in these competitions does not come cheaply; on average, teams can expect to spend $1,000.00 or more in registration, parts, and so forth.

This does not include incidentals, such as travel to and from the event, meals for team members, display booths, t-shirts, and giveaways. Teams competing in the FIRST Techtronics Competition competition can expect to spend $3,500.00–$10,000.00 in addition to incidentals. Students that compete in the FIRST robotics competition can expect to spend anywhere from $10,000.00 to $100,000.00. Most of the teams have corporate sponsorship and are located near more densely populated, urban areas.

Philosophical Framework of Robotics in Education

Robotics "ranks right up there with dinosaurs" when it comes to grabbing the attention of students, keeping that interests is another matter altogether. Often, youth get excited when they see the robots, but as they start to build with the robots and program them, that excitement often turns into frustration as there is no right answer or right way to build and program the robot (Beer, 1999; Karp, Gale, Lowe, Medina, & Beutlick, 2010; Moorman & Parks, 2010; Resnick & Silverman, 2005). This is especially true of children from more rural or economically disadvantaged areas that have not had the experience of working with robots.

Constructivism to Constructionism

Robotics is rooted in Dewey's "participatory learning" and the subsequent work of constructivist educational theorists, specifically Jean Piaget, Lev Vygotsky, and Seymour Papert. Papert (1980) extended the constructivist theory one step further with his philosophy of "constructionism." According to Lau, Tan, Erwin, and Petrovic (1999),

> John Dewey, famous philosopher and educational theorist, believed that a child's natural impulses and personal interests to create, construct, and

> invent should provide the motivation for learning, investigating and thinking. He laid down the foundation of a philosophy of experience. His simple yet far-reaching idea that learning happens best when beginning with direct experiences is the basis for much of the "hands-on" curriculum that we see. Constructing and creating are within the experiences of every young child, and thus is connected to their lives in a meaningful way. The LEGO® system provides the perfect environment for creating the opportunities and meaningful learning. In recent years Seymour Papert and others at the MIT Media Lab have coined the phrase "constructionism" to talk about a related philosophy of learning. (p. 29)

Constructivism, one of the more widely recognized cognitive theories, proposes that learners acquire content more meaningfully when they are provided with the opportunity to independently construct meaning from authentic problems. That is, constructivist theory proposes that in order to facilitate content acquisition, an instructor must provide opportunities for learners to construct knowledge by interacting directly with the content, most typically through the solution of an authentic problem (Druin & Hendler; 2000). Interaction with the content offers students the opportunity to acquire knowledge from personal interaction and is thought to support the independent development of cognitive structures necessary for content acquisition. When students are actively involved in learning, they are more likely to independently acquire knowledge, more likely to be responsible for their own learning, and ultimately more likely to be better prepared to generalize those skills into new settings (Druin & Hendler; 2000).

> Seymour Papert was a student of Jean Piaget during the 1960's and took from Piaget his epistemological view on children as "active builders of knowledge - little scientists who are constantly creating and testing their own theories of the world" (Papert, 1999, p. 7). Papert extended Piaget's the theory of constructivism and extended it to encompass a new theory, constructionism. According to Resnick, Bruckmand, and Martin (1996), Constructionism is not only a theory of learning, but also a theory of education. Therefore, it takes an interventionist perspective and concerns itself with the design of leanring environments (Harel, 1991; Hooper, 1993; Cavallo, 1999) and construction toolkits to support children to make epistemological and personal connections. (Druin & Hendler; 2000, p. 197)

Alimisis et al. (2007) founded the TERECop Project based off of the idea that Papert's constructionism was a natural extension of Piaget's belief that knowledge is constructed especially since it focuses on hands-on activites with tangible objects.

Understanding Contructionism

Constructionism shares a common trait with 4-H project work as well. For constructionists, "learning by making" (Williams, Ma, Prejean, Ford, & Lai, 2007) is the framework in which they work whereas 4-H agents and volunteers work under the motto of "learning by doing." There is a slight change in verbage between the educational theorists and the informal pragmatist, but the result is the same and reveals their common background rooted in philosopher John Dewey and educational theorist Jean Piaget. Papert attempted to create an environment in which children programmed computers and robots. In doing so, the children could identify with the robots because they are concrete, physical manifestations of the computer and the computer's programs. Other researchers have also identified the concrete nature of robots as being one of their important advantages. By testing scientific and mechanical principles with the robots, students can understand abstract concepts and gain a more functional level of understanding (Barker & Ansorge, 2007; Williams et al., 2007).

4-H is uniquely situated to assist local schools in developing the 21st-century workforce. As schools face mounting pressure to increase scores on standardized tests, little time is left for applying the theories learned in the classroom to real world experiences. With the "learn by doing" approach, youth have an opportunity to engage in hands-on activities that bridge the gap between school and work. According to Druin and Hendler (2000), "Opportunities for students to experience a variety of activities that blend school-based, work-based, and connecting activities with high academic standards are essential for students to leave school ready to enter the workforce" (p. 185).

Current Research in Robotics

While the foundation of robotics was forged through the theory of constructionism, its identity as a major influence in education has yet to be defined. Many studies have been conducted on robotics, and most (Rogers & Portsmore, 2004; Mataric et al., 2007) make the constructionist asumption that the act of building the robot or the "artifact itself" is the motivating factor. Most of the research can be broken down into distinct categories, using robotics to aid with problem solving (Barak, 2004; Barak & Doppelt, 2000; Barak & Zadok, 2009; Bers & Portsmore, 2005; Carbonaro, 2003; Chambers et al., 2007; Church, Ford, Perova, & Rogers, 2010; Hussain et al., 2006;

Lindh & Holgersson, 2007; Mauch 2001; Murray & Bartelmay, 2005; Norton, McRobbie, & Ginns, 2007; Petre & Price, 2004; Resnick et al., 2009; Turner & Hill, 2008; Vernado, 2005;), robotics as an agent in STEM curriculum (Adams & Keene, 2005; Brandt & Colton, 2008; Langer & Strothotte, 2007; Nugent, Barker, Gandgenett, & Adamchuk, 2009), robotics use with special needs students (Virnes, Sutinen, & Kärnä-Lin 2008), access to robotics (Druin & Hendler, 2000; Mauch, 2001), and impact of robotics contests (Barak & Zadok, 2004; Petre & Price, 2004; Ruiz-del-Solar & Aviles, 2004; Rusk et al., 2008; Sklar et al., 2003).

Robotics and Problem Solving

At every turn, the NXT robot, the Mindstorm programming language, and the tasks youth are asked to complete, provide a natural environment for problem solving. At the construction level, building the robot presents students with basic engineering problems that can be scaled upward as the child progresses from basic gears and axles to more complicated builds. Mauch (2000) believed that robotics in middle school classrooms could aid students in problem-solving because "it is not always immediately clear why the robot fails to perform a specific function" (p. 2). Additionally, robotics can be used not only with hands-on problem solving but with written problem solving also because it forces the student to articulate why the robot does not run as the student presumed it would.

Beyond the building component of robotics, there exists the programming element that extends the complexity of the robot and requires higher level problem-solving skills (Turner & Hill, 2008). According to Resnick et al. (2009), "Papert argued that programming languages should have a *low floor* (easy to get started with) and a *high* *ceiling* (opportunities for increasingly complex projects over time)" (p. 3). Programming the robot to go in a straight line from Point A to Point B is a relatively easy process, programming the robot to maneuver on a contest mat or to pick up objects is another matter altogether. When students begin programming distances for the robot to travel, they must measure the distance to travel in rotations or degrees rather than in the more familiar inches or feet. For many students, this is the first hands-on experience with the concept that a circle consisting of 360° is equal to one rotation. At this point, students must begin to consider how close the robot gets to the object before it goes too far or runs over the object. This leads the students toward considering half rotations or 180° and so forth. In addition, students must consider issues, such as the amount of power to the motors, how using more power drains the battery life, and so forth, in determining why the robot is acting contrary to their design and programming. Thirdly, the goal of building and programming the robot is almost always to program the robot to perform a task or multiple tasks on a mat or in a confined space. Thus, students must also determine which tasks to perform first. Church, et al. (2010) found that

> By allowing them to solve problems where the answer is not already on an answer sheet somewhere, students learn confidence, problem-solving, teamwork and gain a better understanding of the underlying concepts. Engineering problems, based on real-life situations, provide students with meaningful reasons to learn new material and a powerful educational framework that gives them an opportunity to transfer their knowledge to new situations. (p. 47)

In their research, they found that the more engaged students were with the problem and subsequently solving the problem, the more articulate they became in discussing the concept and scientific principles behind the problem. Norton et al. (2007), found in their qualitative study that LEGO® robotics could be used in the classroom to teach problem-solving skills and design-process skills. They focused primarily on how flowcharting could be used to move children from concept to actualization. Lindh and Holgersson (2007) used both qualitative and quantitative methods to investigate the use of LEGO® robotics on a student's ability to solve logical problems and enhance the student's mathematical performance. They performed two analysis of variance (ANOVA) tests on the sample group and a subgroup of the sample. The ANOVA test on the sample group showed that there was no statistical evidence to support the hypothesis that the average student learns more from incorporating LEGO® robotics. The ANOVA test on the subgroup sample revealed that robotics was more likely to be beneficial for students that were considered "medium good" students.

Engaging Young Minds with Robotics

Nugent et al. (2009) believed the educational robotics and global positioning systems embody hands-on digital manipulatives. Furthermore they believed that robotics also encourages student problem solving and promotes cooperative learning. Also, they believed that robotics can positively influence students' attitudes toward STEM-related concepts and careers. The earlier students are introduced to STEM content areas, the more likely they are to have a positive attitude towards those content areas. Research shows that most girls have already decided by the time they exit kindergarten that "math and science" is not something that girls "do" (Margolis & Fisher, 2002). A recent study conducted called *Georgia Computes!* found that enrollment in computer science classes is at its lowest level since the 1970s. The lack of students entering academic programs in STEM areas is referred to as a "break in the pipeline" (Bruckman et al., 2009).

Research conducted by Brandt and Colton (2008), showed that robotics could be used as a haptic interface to engage students in engineering and science-related courses (2008). Langer and Strothotte (2007) used robots in the college classroom to teach the design process of computerized systems to college students. By engaging youth at an early age, the likelihood of youth pursuing careers in STEM-related areas significantly increases.

Adams et al. (2005) believed that,

> solving problems is what engineers do. Developing creative problem solving skills in engineering students is clearly of vital importance, as highlighted by the many benchmark and policy statements. Effective problem solving is more than simply being able to solve routine or familiar problems; it is also about recognizing strategy and process. (p. 14)

Their research focused on developing a model to engage freshmen engineering students in problem-based learning exercises that would strengthen their problem-solving skills. Chambers et al. (2003) discovered that by using a scaffolding approach with students who were engaged in robotics programming that both learning and problem solving were enhanced as they moved from simple to more complex programming activities.

Robotics as a STEM Pathway

Barker, Nugent, & Grandgenett (2008), utilized an analysis of covariance (ANCOVA) to determine whether or not robotics intervention supported science, engineering, and technology (SET) learning and to evaluate if youth attitudes toward SET concepts were impacted. They found that robotics intervention did impact SET learning but did not impact the attitudes of the youth toward science in any measurable way. Kansas State University founded the Robot RoadShow Program to introduce rural Kansas students to robotics. The main goal of the program was to increase elementary-aged children's interest in STEM-related areas (Matson & DeLoach, 2004).

Robotics and Gender Issues

A major barrier to robotics projects in both the academic and informal learning environments is gender. As previously mentioned, the FIRST robotics competition is the preeminent robotics competition for American youth. However, Rusk et al. (2008) found that robotics competitions "tend to attract a much higher percentage of boys than girls, particularly in free-choice learning environments such as after-school programs and museum classes. Even with efforts to increase female participation, only 30% of the FIRST LEGO® League participants are girls" (as cited in Melchior et al., 2004, p. 2). Research suggests that one reason for this is that girls tend to be more social and prefer working with people rather than working with a computer. Further, boys view the computer as a toy whereas girls see it as a tool, a means to an end. Javonic and Dreves, (1998) found that boys tend to dominate science-oriented activities, especially those involving special equipment, like the LEGO® robotics kits. For girls, the objective of the project is found in the socialization, collaboration, and creativity (American Association of University Women, 2000; Kafai, 1998; see also Volman & van Eck, 2001 as cited in Fancsali, 2003). Davis and Rosser (1996) found that it was important to show girls how the project or technology can help people or impact society. Another indicator of college success in computer science areas is whether or not girls feel that they are proficient in computer programming (Sanders, 2002). Mataric et al. (2007) found that girls face subtle discouragement from pursuing robotics and STEM topics while Weiss (2001) found that there was a general "under-expectation" of girls and a perception on the part of adults that girls needed more help or "rescuing" from difficult problems.

Robotics and Achievement

If robotics can be used as a tool to engage children in STEM subject areas, there is an underlying belief that the use of robotics should also increase achievement scores in those areas. However, the research has proven inconclusive in this area. According to research done by Fagin and Merkle (2003), students enrolled in a robotics-based class achieved less than those in the nonrobotics-based class. The researchers felt that in part this was due to time constraints. Students in the robotics-based class were only able to work on their projects during the assigned lab hours whereas the nonrobotics students could work after hours on their projects. Conversely, Barker and Ansorge (2007) found that using a robotics curriculum in an after-school 4-H group significantly improved the achievement scores of 9–11 year olds.

Limited Access to Robotics

Nearly two decades after the launch of the first LEGO® robot, integration in to the academic mainstream is far more the ideal than the reality. Numerous barriers exist to implementing robotics into the traditional classroom (Druin & Hendler, 2000) and even more so for informal learning environments like 4-H. Barriers include the cost of the robotics kit and time commitment required to learn and implement robotics as an instructional tool. According to Druin and Hendler (2000),

> The new robotics invention product shows promise for the development of problem-solving skills, many questions have yet to be answered. The primary problem centers on cost and classroom implementation. The systems are fairly expensive; many school districts would find their cost prohibitive. In addition, the nature of the product requires a substantial commitment of time on the part of both students and teachers. (p. 2)

Motivation: Robotics as a Mindtool

Constructivist researcher Jonassen (2006) described a mindtool as any computer-based or learning environment that has been created or adapted to encourage learners to construct, develop, and scaffold their experience or object (Jonassen, 2006). While Jonassen did not describe robots in his original definition of mindtools, many later constructivists believe that robots are uniquely qualified to become a mindtool in the hands of eager students. For the constructivist, the robot as a mindtool enables the student to identify the problem and work toward a solution. The motivation is in identifying the problem, building the robot, programming the robot, and realizing a solution to the problem.

There are a handful of research studies conducted on the motivational attributes of youth engaged in robotics. Primarily this research focuses on two concepts: the robot as a motivational force and robotics contests as the motivational force. Petre and Price (2004) used a qualitative approach to discover if robotics could motivate “back-door” learning. They used field notes taken during the RoboCup Junior Robotics contest and videotaped interviews with student teams from four different countries to analyze what makes robotics motivating to children. Their study identified five "drivers" that influenced students:

- The desire to build a better robot
- The determination to finish
- The open-endedness of the pursuit
- The social context
- The prize (to travel and be selected to compete)

Other, lesser drivers cited were "friendship, interest in technology, and a desire to study related disciplines such as engineering or computing" (Petre & Price, 2004, p. 151). While robotics can be used to motivate students and encourage "backdoor learning" of robotics concepts, such as engineering and programming, one researcher found that it took a side-door approach to engage youth in robotics. Rusk et al. (2008) found that "young people who are not interested in traditional approaches to robotics became motivated when robotics activities are introduced as a way to tell a story (for example, creating a mechanical puppet show), or in connection with other disciplines and interest areas, such as music and art." Rusk et al. (2008) also found that if students were engaged in a project that was of personal interest, they were far more likely to press through difficult tasks. Research conducted by Barak and Zadok (2009) corroborate the findings of Rusk et al. (2008). They found that "an increasing number of studies (Doppelt & Barak, 2002; Petre & Price, 2004) have shown that pupils consider the freedom they have in developing their own ideas and using their imagination as major factors influencing their motivation to participate in technology projects" (Barak & Zadok, 2009, p. 290).

Rogers and Portsmore (2004) believed that engineering serves "to motivate student learning of math and science and concepts that make technology possible" (p. 17). They found that by utilizing the LEGO® robotics they could engage a diverse group of student learning styles. Further, they found that there were significant differences in the way girls approached robotics and the way their male counterparts approached the robotics activity. In the study, they discovered that girls were much more likely to be actively involved in the design or investigative process whereas boys tended to go directly to building regardless of whether or not what they built would fit into the overall design scheme. According to Mataric et al. (2007),

> It has long been recognized that experiential, hands-on education provides superior motivation for learning new material, by providing real-world meaning to the otherwise abstract knowledge. Robotics has been shown to be a superb tool for hands-on learning, not only of robotics itself, but of general topics in science, technology, engineering, and math. (p. 1)

Johnson (2003) found that robotics provides a source of energy that can be used to motivate learning. Robotics as a source of energy is not clearly defined, but presumably, the energy is rooted in the constructivist idea that the object itself is motivating. However, Slovakian researcher Janka (2008) found that when he used a bee-bot (a small robot that looks like a bee) to introduce robotics to preschool age children the,

> toy itself wouldn't provide strong motivation to sustain children's attention for a long time. He identified three problem areas: children were not given a "concrete task," learning to control the robot was not overly interesting to the vast majority of preschoolers, and there were too many

children in each group to allow children enough individual exploration of the robot. (p. 6)

Goldman et al. (2004) found in their study that using educational robotics to engage inner city students had the potential to "provide an effective and motivating learning experience" (p. 5). It was considered motivating due to the fact that staff found that students were more willing to participate in the robotics class than their other classes and that those students were more likely to participate in challenges they deemed "cool." Gabauer, Bayse, Terpenny, and Geoff (2007) believed that students were easily discouraged with difficult design problems, but if the task could be broken down into small parts that students could achieve and be successful at early on, their motivation was increased (p. 3). Fagin and Merkle (2003) stated in their research that "educators have thought about robotics in the classroom for as long as they have thought about robots: their potential as teaching tools and as motivators has long been recognized" (p. 1).

Motivation Due to Contest

FIRST Robotics held its inaugural robotics competition in 1992. The FIRST LEGO® League competition, which uses the LEGO® Mindstorm robot, was not held until 1998. However, the FIRST robotics competition remains the preeminent competition in North America. Gabauer et al. (2007) found that even the "smallest of successes can be an enormous motivator" (p. 4). In their study, they had college students mentor school-aged children through the FIRST LEGO® League competition. They found that focusing on smaller aspects of the contest and succeeding at those tasks built the group members' confidence, and subsequently, they were motivated to accomplish more tasks.

In 1998, another robotics competition was launched entitled RoboCup Junior. Its inaugural competition and showcase was held in Paris, France. Every year, the contest is held in another country. The contest revolves around participants building a robot that can perform in one of three categories: soccer, rescue, and dance. The RoboCup Junior competition is open to any child that can read, regardless of age up until he or she turns 19 years old. It is divided into primary and secondary students. In their research of RoboCupJunior challenge, Sklar, et al. (2000) found that

> all of the teachers reported that the RoboCup Junior competition itself was a motivating factor, particularly because: it is an international event, imposes an absolute deadline (i.e., the date of the conference is fixed) and it gives children an entry-level role in the complex and stimulating field of robotics research. Several teachers commented that the fact that the young entrants participated alongside the senior competitors, some of the top robotic scientists in the world – was a tremendous motivating factor for them and their students. (p. 10)

They concluded that robotics [RoboCup Junior] had the same motivational characteristics as video games and that students tended to spend longer preparing for the competition. However, in subsequent research done by the same authors, one issue that arose was the subjects' ability to objectify motivational factors:

> Subjects are children who may not be able to measure accurately various motivational factors on a 5-point scale (e.g.). Second, the international composition of RoboCup Junior brings forth language and cultural issues

> more than in the senior leagues, since young students are less likely to be able to factor out cultural issues than adults. (2002, p. 7)

One study in particular conducted by Virnes et al. (2008) examined the intrinsic and extrinsic motivational factors that influence students and teachers who participated in the RoboCup competition. This is one of the few studies that uses a behavioralist framework (i.e., intrinsic and extrinsic motivation) to study a constructivist activity. In evaluating the RoboCub Junior league, researcher Virnes discovered that "the motivational results reveal that professors view RoboCup as slightly more motivating than students in terms of attitude towards the subject matter and practical issues, while students view the fun of the robot soccer game as more motivating than professors" (as cited in Skylar, et al., 2003, p. 6). Barker (2008) believed that students were more excited about the idea of an academic competition more so than actually pursuing a career in a STEM-related area. Another issue is that robotics contests among groups are highly motivating. Children get extra stamina from performing a good work should "the group's robots defeat all other robots" (Ruiz-del-Solar & Aviles, 2004). Further, Barak and Zadok (2009) found that students who built a robot for competition were far more motivated than students who were in a content-oriented classroom that focused on robotics. They also found that the role of teacher was greatly reduced and that students spent a great deal of time outside of the classroom working on the robot (2009).

Impact of Adults on Motivation

Adults play a key role in student's motivation. Goldman et al. (2004) found that the attitudes of the adult supervisors made a significant difference in students' attitudes towards learning.

> For example, a supervisor in one of the Science and Technology Entry Program classes provided a strong positive influence for his students during the robotics lessons. Although he did not have much knowledge about robotics, he showed interest in student's activities and cheered their accomplishments. His positive attitude and interest motivated some students to succeed in the challenges in order to show him what they had done. On the other hand, the supervisors in the other STEP class did not pay any attention to the robotics program. They came to class with their students, but spent most of their time surfing the Internet. This negative attitude did, indeed, lower the student's motivation in comparison with the other classes. (p. 7)

Stakeholders Involvement with Robotics

Identifying volunteers that could form the backbone of the robotics program in Mississippi is a critical cornerstone of building the robotics program. Volunteers provide much needed guidance to youth and often serve in a coach or mentor role. Brand et al. (2008) found that "Mentorship is vital to the robotics program" (p. 45). Students who competed in a FIRST robotics competition often met after school with mentors from Virginia Polytechnic Institute and State University (Virginia Tech) to work on the robot. Undergraduate mentors would receive a class in mentoring before working with the high school students and then receive course credit for their efforts to mentor the students. According to Brand et al. (2008), the role of the undergraduate mentor was to act as a facilitator by "posing questions and encouraging discussions, analysis, and explanations of problems" (p. 45) without giving the answer to the problem at hand. Their role was to act as "middle management" and provide direct one-on-one attention to the students. An article entitled "Afterschool and Summer Programs: Committed Partners in STEM Education" (Afterschool Alliance, National Afterschool Association, and National Summer Learning Association, 2010), stated that by exposing youth to mentors with detailed backgrounds in STEM-related fields, youth can begin to envision themselves in careers similar to those of their mentors.

Barker (2007) conducted a survey of 1,414 Nebraska families to determine how Nebraska 4-H should plan and develop new science and technology programs. Of the 1,414 surveys mailed out, 498 surveys were returned. While the response rate was too low to generalize beyond Nebraska families, it did reveal interesting perceptions of stakeholders' opinions of 4-H and technology. The survey found that Nebraska stakeholders are interested in 4-H offering technology-related programs; however, they did note that the technology-related programs should relate back to agriculture. Another finding of import from the survey was the general consensus of stakeholders that they do not have the education or abilities to offer ideas on technology-related programs.

While no study has yet been conducted on Mississippi 4-H volunteers, the anecdotal evidence corresponds to the findings in Barker's research. Often, the first words out of a volunteer's mouth are, "I don't know anything about robotics," or similarly, "Robotics is beyond me; these kids know more about it than I do."

In a follow-up article to their findings in 2007, Barker et al. (2008) argued that a new model is needed to develop volunteer competencies in science, engineering, and technology programming areas. What Barker and his colleagues (2008) found was that programming rich in science, engineering, and technology programs does not rely on the traditional 4-H adult volunteers to deliver the content; rather it relied on paid staff due to the "intensity of the program" (Barker et al., 2008). Barker et al. (2008) found that five of the eight SET programs do not use volunteers in their delivery models. The reasoning behind this is that volunteers do not typically possess the knowledge to lead clubs in these areas. What Barker et al. (2008) discovered was that a new training model was needed to keep youth and adult volunteers engaged. They included four competencies in their training model: face-to-face training, online modules, monthly Web meetings, and self-directed learning opportunities. As part of this "new" model, the researchers believed that volunteers would build and program a robot through self-directed learning prior to engaging the youth so that they have a better understanding of the goals of the program (Barker et al., 2008).

Motivation and Behavioralist Theory

According to Merriam-Webster, motivation is the act of motivating or of being motivated. To be motivated means to have a reason for doing something. These "reasons" or "drivers" or "factors" must be closely examined to understand what motivates youth, volunteers, and stakeholders to participate in the 4-H robotics program. Understanding what motivates youth is extremely critical, if by dissecting what motivates them, teaching strategies and activities can be developed to maximize the impact robotics would have on youth in Mississippi. Papert (1980) believed that

> our children grow up in a culture permeated with the idea that there are 'smart people' and 'dumb people.' Within this framework children will define themselves in terms of their limitations, and this definition will be consolidated and reinforced throughout their lives." (p. 43)

According to Lau et al, (1999),

> Too often in schools these days there is one right answer to a question. When students have the notion that there is one right answer, it can often scare them into not even trying to think about it. If they give their version of the answer, it might be wrong, and they will immediately be labeled as stupid. (p. 124)

Ruiz-del-Solar and Aviles (2004) found that,

> children's self-motivation seems to be the key element for their success during the workshop. Unmotivated children do rather poorly. The group structure also plays an important role. Best behavior occurs when previously unknown participants meet each other for the first time during the workshop to form a working team. (p. 477)

As stated previously (Rusk et al., 2008), robotics can be used as a back door for other disciplines to gain a foothold in the fertile minds of young learners. In the book *Robots for Kids: Exploring New Technologies for Learnin*g, Druin and Hendler (2008) found that

> the importance of enabling children to take part in projects that are multidisciplinary in nature cannot be overstated. Construction material and project ideas that appeal to a broad range of interest allow multiple entry points into science, mathematics, engineering, design, art, and music for all types of learners. These material not only make new knowledge domains accessible, but also provide new ways for children to relate to domains of knowledge to which they have already been exposed. (p. 22)

Unlocking the key to the motivational factors that influence youth, volunteers, and stakeholders to participate in robotics holds the key to program development.

The theory of motivation, particularly extrinsic motivation, rests in the behavioral theorists such as B.F. Skinner and Abraham Maslow. Extrinsic motivation according to Ryan and Deci (2000) "is a construct that pertains whenever an activity is done in order to attain some separable outcome" (p. 2). Verner (1998) found that only 35% of participants in the RoboCup Junior competition identified extrinsic factors, such as completing challenges and winning the competition, as highly motivating. McWhorter and O'Conner (2009) conducted a Motivated Strategies for Learning Questionnaire in their college computer science class. They found that students in the test group (using LEGO® Mindstorm) had significantly less extrinsic goal orientation, meaning that the students were less motivated to learn about the robots for the sake of their grades. Further, the researchers initially assumed that as the extrinsic levels dropped the intrinsic levels would go up. However, this was not the case. Research shows that students' ability to be influenced by extrinsic motivation declines over the course of their schooling due to tests, rewards, and the lack of relevance of the subject to their everyday lives. According to the *Learning for the 21st Century* report (Crane et al., 2003), even though there has been a significant focus on improving student achievement, there remains a disconnect between the knowledge and skills students learn in the classroom and the skill set needed to work and be productive in the 21st Century. The report also stated that "today's educational system faces irrelevance unless the gap is bridged between how students live and how they learn" (Crane et al., 2003, p. 5). Ryan and Deci (2000) found that many of the tasks students were being asked to perform were not particularly interesting and that teachers will have to promote more methods of extrinsic motivation that students voluntarily engage in if they are to be successful. Further, they found that

> because extrinsically motivated behaviors are not inherently interesting and thus must be initially be externally prompted, the primary reason people are likely to be willing to do the behaviors is that they are valued by significant others to whom they feel (or would like to feel) connected, whether that be a family, a peer group, or a society. (Ryan & Deci, 2000, p. 64)

Most motivational theorists agree that extrinsic motivation is a poor, but often necessary, addition to the students' intrinsic motivation. Ryan and Deci (2000) explained it thusly:

> For example, the more students were externally regulated the less they showed interest, value, or effort, and the more they indicated a tendency to blame others, such as the teacher, for negative outcomes. Introjected [sic] regulation was positively related to expending effort, but was also related to more anxiety and to poorer coping with failures. Identified regulation was associated with greater enjoyment of school and more positive coping styles. And intrinsic motivation was correlated with interest, enjoyment, felt competence, and positive coping. (p. 63)

Lepper and Henderlong (2000) argued that extrinsic rewards that highlight the students' competence (i.e., praise, recognition) and are not expected by the student nor physically tangible (i.e., candy, trophy, etc.) can stimulate the students' intrinsic motivation. Intrinsic motivation is more often associated with social-cognitive theory, as theorists, such as Piaget and Jonassen, are more concerned with how learners internalize and construct knowledge. Intrinsic motivation can best be defined as the individual constructing knowledge autonomously. Ryan and Deci (2000) described intrinsic motivation as "intrinsically motivated behaviors, which are performed out of interest and satisfy the innate psychological needs for competence and autonomy are the prototype of self-determined behavior" (p. 65). Brandt and Colton (2008) believed that people learn when what they learn is personally meaningful to them, what they learn is challenging and they accept the challenge; what they learn is developmentally appropriate, they can learn in their own way, have choices, and feel in control; they use what they already know as they construct new knolwedge; they have opportunities for social interaction; and they receive helpful feedback (p. 11). Barak and Zadok (2009) found that "an increasing number of studies (Doppelt & Barak, 2002; Petre & Price, 2004) have shown that pupils consider the freedom they have in developing their own ideas and using their imagination as major factors influencing their motivation to participate in technology projects" (p. 290). Understanding the instrinsic factors that motivate participants in the robotics program is critical. According to Ryan and Deci (2000), "Because intrinsic motivation results in high-quality learning and creativity, it is especially important to detail the factors and forces that engender versus undermine it" (p. 55).

Bibliographic History of Robotics Program Development in Mississippi

In the spring of 2007, I was invited to attend the FIRST International Robotics Competition in Atlanta, GA. The international robotics competition draws over 10,000 children from all over the world as they engage in 3 days of robotics competition. To compete at the international level, students must win their state or county competitions and then their regional competitions. For example, a student from Mississippi would need to win the state competition held at the John C. Stennis Space Center in Biloxi, MS and then advance to and win the regional competition in New Orleans, LA. With the cost of the FIRST techtronics challenge and FIRST robotics competition, I knew that Mississippi 4-H robotics was not prepared to engage at that level starting out. However, two of the competitions, JLL and FIRST LEGO® League, required far less money and were more containable in both scope and delivery. Both of those competitions use an 8 x 4-ft playing mat where students can build and program an NXT robot to perform certain tasks. The contest usually revolves around a scientific concept (such as global warming), and the participants are asked to prepare a report on the issue and how their robot will help solve the problem. Brand recalled that "the robotics program engages students in science through a nontraditional approach, as students explore the field of robotics as a real-world discipline in which fundamentals learned are put to practical use" (Brand et al., 2008, p. 45). Further, the participants are asked to present their research to a panel of judges and the students are scored on the performance of their robot, their notebook, table display, presentation, teamwork, and gracious professionalism. Gracious professionalism is a concept that was coined by founder Dean Kamen to encourage participants to act in a manner that is both gracious and professional even in the midst of intense competition. It is equivalent to sportsmanship in athletics.

Introducing Robotics as a Viable Mississippi 4-H Project

While the possibility for engaging Mississippi 4-H youth with the FIRST competition was an exciting proposition, the reality was far less certain. With the average county 4-H budget hovering somewhere in the vicinity of $200.00–$5,000.00, a commitment of this magnitude would be an enormous drain on the budget and unrealistic.

Budgets at the county level are used to host end-of-year award banquets, buy ammunition and targets for shooting-sports contests, and provide snacks and craft supplies for monthly club meetings. Knowing that the FIRST robotics competition would be a long-term goal for the Mississippi 4-H program, it was decided that smaller, intermediate goals would be set to help the fledgling Mississippi 4-H robotics program reach FIRST competition. Among those smaller goals was to build an awareness of robotics through hands-on workshops, camps, and 4-H agent in-service classes and to generate excitement about robotics (thus reducing fear of the unknown). Another short-term goal was to begin the process of building the skills necessary for the 4-H'ers to create and program robots, to recruit the volunteers necessary to form a supportive network within which the 4-H'er could "learn by doing," and to identify stakeholders that would be open to partnering with 4-H in sponsoring robotic teams at the local-county level.

Thus far, robotic volunteers in Mississippi tend to be parents whose children have a natural inclination toward robotics and haptic learning environments. Volunteers tend to fall into three categories: parents who home school and are looking for new subject areas in which to involve their children, teachers who are looking for additional materials to use with their class, and college students with whom the 4-H agent has worked in the past and who feel like they have a better handle on "this new-fangled technology" than the 4-H agent does.

For Mississippi, relying strictly on state-level staff to provide the training for robotics programming is perhaps easier at the onset of a project but over time the drain on staff and resources would be such that the sustainability of the overall project would be questionable.

Building the Future of Mississippi 4-H Robotics

The Mississippi 4-H robotics program began as a joint effort between the department of Computer Applications and Services at the Mississippi State University Extension Service and the Mississippi 4-H program in the summer of 2007. Computer Applications and Services purchased an initial 12 base robotics kits and held the inaugural workshop in a rural Mississippi county. It was the first time I or the 4-H agent had ever used the robots, and it was also the first time youth from this county had seen or worked with anything like the NXT robots. More workshops were offered in the summer of 2008 as were other subsequent robotic workshops across Mississippi. The response from the youth in this county to building and programming the robots was such that it encouraged us to continue pursuing robotics with Mississippi 4-H youth even though the obstacles to overcome would prove formidable.

With a national mandate to engage more youth, one million to be exact, in science, engineering, and technology projects, less than 1% of Mississippi 4-H'ers engaged in technology-related projects; overcoming obstacles would prove to be a necessity, not an option. According to the United States Department of Agriculture, (2011):

> America faces a future of intense global competition with a startling shortage of scientists. In fact, only eighteen percent of U.S. high school seniors are proficient in science (NAEP, 2005) and a mere five percent of current U.S. College graduates earn science, engineering, or technology degrees compared to 66% in Japan and 59% in China. To address increased demand for science and technology professionals, 4-H is

> working to reach a bold goal of engaging one million new young people in science programs by 2013. (para. 1)

Furthermore, Jamison (2008) wrote in her article entitled "Growing a New Crop of Engineers" that schools alone cannot handle the need for more SET programming. As the national project director for SET curriculum at the National 4-H Council, she believed that "out-of-school programs like those offered by 4-H are so rich in hands-on projects and adult participation" that they can better prepare young people to be active, competitive participants in creating their future" (para. 22). To support her claims, the Afterschool Alliance wrote that "when combined with the traditional school day, afterschool and summer programs constitute an ideal space for getting children and youth excited about STEM learning and careers" (para. 5). The report further stated that the environment created in after-school activities is, by nature, more conducive to the scientific method of inquiry and hands-on learning and provides a safe place for exploration without fear of failure. According to the article, "children can explore STEM topics of their choosing and undertake longer-range projects without fear of academic failure" (para. 6).

In May of 2009, Computer Applications and Services hosted the pilot robotics contest at the State 4-H Congress competition in Starkville, MS. Senior 4-H'ers, ages 14–18, came from all over Mississippi to compete in a wide array of competitions. In an effort to encourage participation and reduce the fear of the unknown, it was thought best to combine an element with which 4-H youth and agents were very familiar (the State Fair) with an element that was completely foreign to them (robotics) in an effort to allay fears over using the robot. For the robotics competition, an 8 x 4-ft mat was created with a State Fair theme (see figure 1). Many 4-H'ers participate at the State Fair, and every agent is required to work the State Fair, so it was a known quantity to everyone involved.

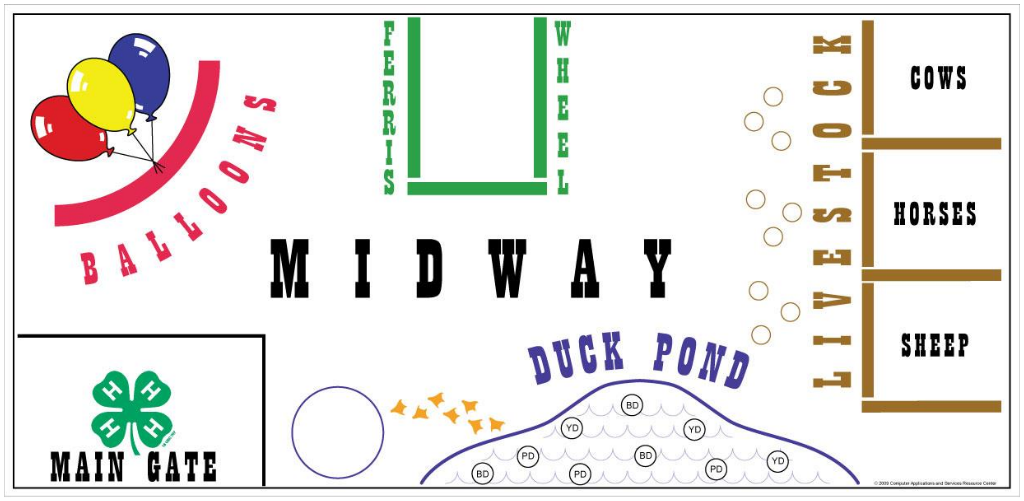


Figure 1. State Fair robotics competition mat

In an effort to give youth more hands-on access to the robot, the team size was limited to 3-4 members whereas FIRST robotics teams typically consist of 10–12 students. In the pilot year 10 teams competed, representing nearly 40 youth from eight counties in Mississippi. In addition to building and programming a robot to compete on the contest mat, youth also had to write a report on their activities, present their work to a panel of judges, and create a video on the topic selected. The look and feel of the FIRST robotics competition was purposefully mirrored so that youth could move seamlessly between the two contests as they built up their skill levels and volunteer networks. Overall, the pilot contest was a success. Over the course of the summer, several more workshops and camps were offered to encourage more youth to participate in robotics and give them and their volunteers exposure to building and programming with the robots.

In 2009, the robotics program expanded to incorporate the Junior 4-H'ers. A Junior 4-H'er is defined as any 4-H youth aged 10–14 years old. However, due to the popularity of the robotics project among Junior 4-H'ers, 8–9 year olds were allowed to compete as well. Traditionally, youth aged 5–7 compete in the Cloverbud category. Cloverbuds are allowed to participate but cannot rank in competition. In Massachusetts, the state educational framework requires introducing children to engineering by first grade. By contrast, Mississippi youth are required to take Integrated Computer and Technology in either the seventh or eighth grade in addition to a STEM content-area class in the ninth grade. In the book *High Tech Tots* (Berson & Berson, 2010), the authors argued that "technology is now such an important part of children's everyday lives that a learning environment without it would be completely out of touch with their own realities" (Berson & Berson, p. 2). Berson and Berson (2010) argue in chapter four of *High Tech Tots* that early childhood classrooms spend more time teaching young minds about polar bears and cacti for which they have no reference than the technology that surrounds their daily lives and with which they are more accustomed. Bers (2008) found that "technology can provide a playful bridge to integrate academic demands with personally meaningful projects" (p. 11). In a previous article, Bers et al. (2002) found that robotics is uniquely fitted to the early-learning classroom as early childhood education is associated most distinctly with constructionist methods of teaching. In addition, the early childhood classroom is more integrated across subjects and is not required to "fit" into an hour-long block of time. According to Bers et al. (2002),

> In elementary and high school education, there sometimes exists the tension between an instructionist model of teaching, in which the teacher's role is to instruct students by transferring or providing information, and a constructionist model. However, in early childhood education there is a general agreement about the efficacy of "learning by doing" and engaging in "project based learning." (p. 4)

The fastest growing segment of participants in the 4-H robotics project is youth between the ages of 8 and 12 years old. In an effort to engage children as early as possible, the Robot Round-Up was introduced at the Mississippi State Fair in 2010. At this competition, Cloverbuds (4-H'ers who are 5–7 years old) were allowed to build a "baby" animal robot using the WeDo® robotics kit from LEGO®. The WeDo® robotics kit is a beginner robotics kit that costs $129.95.

The Cloverbuds enjoyed the building and the competition, but most complained that the robot was "too easy" to build and "too limited" in its programming. They let us know in no uncertain terms that they preferred to work with the NXT robotics kits. In January of 2011, Computer Applications and Services (CAS), in partnership with 4-H, hosted the PAVE Robotics Kick-Off. PAVE is an acronym for Parents, (4-H) Agents, Volunteers and Educators coming together to pave the future through 4-H robotics. Initially, it was hoped that there would be 30–50 youth and adults register for the day-long kick-off. Registrations were quickly overwhelmed with applications and ended up having to host a second kick-off to accommodate the nearly 200 applicants. On the day of kick-off, youth participated in a day-long robotic build while adults worked through the 5-month robotic curriculum created by CAS. Adults left with a notebook full of lesson plans and supplemental materials to use with their 4-H'ers as well as a few starter materials. Prior to the kick-off, follow-up dates or "club meetings" were scheduled for once a month from January to May. These monthly meetings were conducted over the Extension Service's interactive video network and enabled CAS staff to work with youth and adults on robotic builds and develop programming skill sets. The interactive video network is maintained by the Distance Education group, a subgroup within CAS. Every county Extension Service office in the State of Mississippi has a portable Polycom videoconferencing unit attached to a 27-in. television on which participants can view the remote speaker. Additionally, the unit comes with microphones that participants can use to communicate with presenters at the far site. The meetings begin with a hands-on scientific activity that reflect the robotic topic for the month and is done as a group. The activity is led by CAS staff and usually takes anywhere from 20 to 30 min. The remainder of the club meeting time is spent on a short programming activity that uses the NXT programming software and is designed to develop the 4-H'ers programming skills. The entire club meeting lasts around an hour.

Summary

From the review of literature, there is a wide range of research on the use of robotics but very little on motivation and robotics specifically. The literature review further highlights the role robotics plays in bringing together the three major learning theories: behavioralism, cognitivism, and constructivism. It also details the emergence of the constructivist approach to learning. According to Druin and Hendler (2008),

> One concern about the widespread introduction of technology into children's lives is that we are becoming enslaved to technologies that are

> not understand. Instead, it is important that the next generation of children gains a sense of control, ownership, and empowerment, and becomes actively involved in understanding and designing our future. (p. 32)

In order to design our future, it must first be understood what motivates students, volunteers, and stakeholders. This review of the literature reveals that there is no concensus among researchers when it comes to identifying motivational factors of participants engaged in robotics.

CHAPTER III

METHODS

Introduction

Robotics has grown from the research laboratory to the educational mainstream, serving as a pathway for youth to experience science, technology, engineering, and math in a contained, measured environment. The amalgamation of 4-H youth programming with robotics has the potential to be transformative. Traditionally, 4-H has had a strong presence in leadership, public speaking, group building, and youth-adult partnerships. The introduction of robotics into 4-H exposes a different genre of youth to future possibilities in science, math, technology, and engineering. Robotics has been studied in formal learning environments (Adams & Keene, 2005; Atmatzidou et al, 2008; Barak & Zadok, 2009; Beer et al., 1999; Bers, 2008; Bers et al., 2002; Berson & Berson, 2010; Brandt & Colton, 2008; Brandt, Collver, & Kasarda, 2008; Church et al., 2010; Erwin et al., 2000; Lau, 1999; Lundy, 2007; Mauch, 2000; Norton et al., 2007; Portz, 2002; Robinson, 2005; Rogers & Portsmore, 2004; Swartz, 2007; Whittier & Robinson, 2007), such as middle schools, high schools, and colleges, but very little research has been done in the area of robotics in the informal educational system (Barker, 2008; Barker & Ansorge, 2007; Bourdeau, 2007; Elmore & Seiler, 2008; Fancsali, 2003; Goldman et al., 2004; Nugent et al., 2009).

This chapter provides an overview of the methodology and procedures utilized in this research study. Included in this discussion is an overview of the research design, rationale for the design selected, appropriate context of the study, setting of the study, description of the participants, data collection, analysis, as well as issues of credibility and rigor.

Bounded Case Study Research Design

According to Merriam (1998), qualitative research is based on the view that "reality is constructed by individuals interacting with their social worlds" (p. 6). In essence, qualitative research seeks to understand the situation in the context of the people who are living and breathing that context into existence. For Patton (1985), qualitative research assumes that "meaning is embedded in people's experiences and that this meaning is mediated through the investigators' own perceptions" (as cited in Merriam, 1998, p. 6). The qualitative researcher seeks to understand how the pieces fit together to form a mosaic that the research can step back from and see the overall picture. Each tile in the mosaic is unique to the person, to the place, and to the time but when studied in their context they reveal intricacies that lead the researcher to a broader understanding of the situation. Furthermore, qualitative research provides rich, thick descriptions that yield a tangible knowledge of the world around us.

Qualitative research rests on the philosophical ideas of phenomenology, symbolic interaction, constructivism, post positivism, and critical social science (Merriam, 1998). While the philosophies may seem vast, they represent the array of qualitative research types amongst the spectrum of genres, such as education, anthropology, ethnography, and so forth. Given that 4-H is an informal educational organization, it only seems appropriate to align this study within the context of a qualitative educational research approach. In their seminal work *Becoming Critical,* authors Carr and Kemis, as cited in Merriam (1998), defined three types of educational research: positive, interpretive, and critical. Merriam (1998) explains that in positivist research, "education or schooling is considered the object, phenomenon, or delivery system to be studied" and it is objective as well as quantifiable (p. 4). The interpretive researcher believes that "education is a process and school a lived experience. Understanding the meaning of the process or experience constitutes the knowledge to be gained from an inductive, hypothesis—or theory generating (rather than a deductive or testing) mode of inquiry" (Merriam, 1998, p. 4). The last type, critical research, is drawn from the Marxist philosophy and holds that "education is to be a social institution designed for social and cultural reproduction and transformation" (Merriam,1998, p. 4). Of these three, the interpretive qualitative approach is the most appropriate foundation for this particular research study because it allows the researcher to learn how individuals experience and interact with their social world (Merriam, 1998, p. 4).

Within the discipline of qualitative research, there are five major research types: basic/generic qualitative study, ethnography, phenomenology, grounded theory, and case studies. Case studies form the cornerstone of educational research due to the fact that this type of research involves the study of an issue explored through one or more cases within a bounded system (Cresswell, 2007, p. 73). Similarly, Yin (1994) defined the case study as "an empirical inquiry that investigates a contemporary phenomenon within its real-life context, especially when the boundaries between phenomenon and context are not clearly defined" (p. 13). For Merriam (2009), the case study can be defined as, "a thing, a single entity, an unit around which there are boundaries" (p. 27). Further, she argued that the single most defining aspect of the case study is to determine the limits of the case which in turn bounds the study, identifying clearly what will and will not be studied. Case studies are:

- More Concrete – Case study knowledge resonates with our own experience because it is more vivid, concrete, and sensory, than abstract.
- More Contextual – Our experiences are rooted in context, as is knowledge in case studies. This knowledge is distinguishable from the abstract, formal knowledge derived from other research designs.
- More developed by reader interpretation – Readers bring to a case study their own experiences and understanding, which lead to generalizations when new data for the cases are added to old data.
- Based more on reference populations determined by the reader – In generalizing as described above, readers have some population in mind. Thus, unlike traditional research, the reader participates in extending generalizations to reference populations (Merriam, 1998, p. 31–32).

In this research, the case to be studied includes participants from two 4-H robotics clubs in Mississippi located in two separate counties. This interpretive case study was designed to investigate the factors which motivate 4-H youth to participate in the robotics program. As motivation can be both intrinsic and extrinsic, the 4-H agents, volunteers, and administrators (who are often also parents of 4-H youth) will also be included in the study to explore what role if any they have on motivational factors.

In order to investigate this issue, assortments of qualitative research tools were utilized. These tools included interviews, observations, document analysis, and artifact collections. Interviews formed the core of the research with observations, document analysis, and artifacts used as additional information to support, clarify, or contradict information gathered from the interviews. Interviews were both structured and semi structured to provide the greatest opportunity for participant response. Interviews were essential to understanding the internal and external processes by which youth are motivated to participate in robotics. In addition to the 4-H youth, those persons who can affect that process (parents, volunteers, and 4-H agents) were interviewed to investigate their roles. According to qualitative researcher and author Seidman

> Interviewing provides access to the context of people's behavior and thereby provides a way for researchers to understand the meaning of that behavior. A basic assumption in in-depth interviewing research is that the meaning people make of their experience affects the way they carry out that experience. . . . Interviewing allows us to put behavior in context and provides access to understanding their action. (as cited in Merriam, 1998, p. 4)

Thus the qualitative researcher uses interviews to investigate the respondents' views of the world and their subsequent experiences (Merriam, 1998).

Observation is yet another crucial tool at the disposal of the researcher; however, it is a secondary tool. Observing the phenomenon within the context of the case is essential to developing a holistic framework in which to analyze the interviews. According to Merriam (2009), there are six basic elements present in any situation:

- The physical setting – What is the physical environment like? How is space allocated? What objects, resources, and technologies are in the setting?
- The participants – Describe who is in the scene, how many people and what are their roles? Who is not here? What are relevant characteristics of the participants?
- Activities and interactions – What is going on? How are people and activities connected?
- Conversation – Who speaks to whom? Who listens?
- Subtle factors – Non-verbal communication such as dress and physical space, What is not happening – even it should be happening?
- The researchers' behavior – How is the role of researcher or intimate participant, affecting the scene you are observing? (p. 120- 121)

Opportunities for observation include robotics workshops, camps, contests, and interactive video meetings. At the county site, observations include facilities, other Extension Service staff (county director, subject specialist, extension associates, and office associates) attitudes toward the youth and to the robotics program, and geographical distance between the Extension Service office and where the youth live. County Extension staff routinely work together and work outside of their designated program areas to ensure the overall success of the county's outreach efforts. For example, an Extension office associate might serve as 4-H volunteer and lead a club. In another county the County Director whose specialty area is horticulture might serve as the primary robotics leader in the county with the 4-H agent supporting her.

The third tool that will be utilized is document analysis. Available documents, such as newspaper articles, photos, videos, and 4-H record books will help to identify what in particular the participants thought were important (in the case of the record books) or what the community deemed important (newspaper articles). Further, document analysis could show common themes and connections between youth that indicate common motivational factors.

Artifacts constitute the fourth and final tool that will be utilized in this study. The robot itself acts as an artifact attesting to motivation of the youth to build it, program it, and showcase it. Further, recorded videos of previous competitions submitted by youth and recorded robotics video club meetings can be used to discover themes across time.

These four tools when used together in this qualitative study will work together to piece the mosaic together. According to Merriam (1998), "Qualitative research reveals how all of the parts work together to form the whole" (p. 6). In this study, the artisan, or the researcher as the case may be, is the primary instrument by which the mosaic is revealed (Merriam, 1998). The researcher bears an ethical responsibility to identify the effect he or she has upon the research and to account for it in the analysis of the data.

Qualitative case studies provide a circumference in which the parameters of the study may be investigated. This study will explore the intrinsic and extrinsic factors that influence 4-H youth to participate in robotics even though it is extremely difficult and quite foreign to Mississippi youth, particularly 4-H youth. Yet time has shown that some youth have persevered in the robotics program while other youth either never get started or falter upon start-up. This interpretive qualitative case study will hopefully yield information that can be used to engage and motivate future 4-H youth to pursue the robotics program with the appropriate support system underpinning their efforts. Further, by increasing the number of youth participating in and engaging with the robotics program, Mississippi's pipeline of scientists, engineers, and technology specialists stands to receive a much-needed influx.

Rationale for Using a Bounded Case Study Research Design

The purpose of this case study is to identify what factors, whether intrinsically or extrinsically, motivate 4-H youth to pursue and remain in the robotics program. The following research questions will guide the study and provide manageable parameters for this research. Each of the five questions listed below contains sub questions to further engage the participant and gain a holistic understanding of what factors influence participants to engage in robotics. The questions originate both from the literature review and issues of interest that arose from the robotics pilot year.

1. Are 4-H youth intrinsically or extrinsically motivated to participate in robotics?
2. What motivates volunteers to help 4-H youth participate in robotics projects?
3. Are the factors that motivate 4-H boys different than that which motivates 4-H girls?
4. What role if any does ethnicity play in the motivational attributes of 4-H'ers, volunteers, agents, and stakeholders?
5. What is the role of varying factors of motivation in success? What does "success" in the robotics project mean for the youth, agents, volunteers, and stakeholders?
6. What role do administrators have in promoting robotics, and how are those efforts perceived by youth, volunteers, and staff at the county level?

These questions seek to engage participants and present them with an opportunity to shares responses and stories so that the 4-H youth, agents, volunteers, and stakeholders may come together as one voice to once again renew the vision. A vision that encourages youth to “learn by doing” so that they are better prepared to participate in a new economy, an economy less reliant on agriculture and more reliant on technology-driven jobs. Today, the youth of Mississippi face a new challenge—to transition from the rich agricultural history that has sustained us to a technology-driven workplace. However, in order to facilitate the transition, the intrinsic and extrinsic motivational factors that bring participants to robotics must be understood.

Rationale for the First Research Question

The first research question seeks to identify characteristics of the participants’ narrative that are uniquely intrinsic or extrinsically motivated. According to Ryan and Deci (2000), “The most basic distinction is between intrinsic motivation, which refers to doing something because it is inherently interesting or enjoyable, and extrinsic motivation, which refers to doing something because it leads to a separable outcome” (p. 55). Further, the authors gave credence to the need to identify the “factors and forces” that influence participants; “because intrinsic motivation results in high-quality learning and creativity, it is especially important to detail the factors and forces that engender versus undermine it” (Ryan & Deci, 2000, p. 55). Conversely, “Students can perform extrinsically motivated actions with resentment, resistance, and disinterest or, alternatively, with an attitude of willingness that reflects an inner acceptance of the value or utility of a task. In the former case—the classic case of extrinsic motivation—one feels externally propelled into action; in the later case, the extrinsic goal is self-endorsed and thus adopted with a sense of volition” (Ryan & Deci, 2000, p. 55). Both intrinsic and extrinsic factors contribute to an understanding motivation theory, which arises out of the behavioral theories of learning. Robotics brings together two diverse theories at a crossroads: constructionism, which is birthed from constructivism, and motivational theory, which as stated previously arises from behavioral theory.

Rationale for the Second Research Question

The second question addresses 4-H agents and volunteers. Without a commitment of time, energy, and resources by agents, volunteers, and stakeholders, there can be no future for the robotics program in Mississippi. These individuals are the conduit for exposure. They bear the primary responsibility for arranging meeting times, working with local schools and churches, securing resources for supplies, transporting children to and from club meetings, and serving as the primary facilitators during robotics club meetings.

Rationale for the Third Research Question

Gender inequality in STEM-related areas has been well documented. However, the third question examined factors that motivated girls to pursue robotics specifically:

> Research indicates that gender differences in performance are related to common, ordinary difference in the mathematics and science education of girls and boys (e.g., sex-role stereotyping about mathematics and science skills) – differences that contribute to different interests, attitudes, achievements, and enrollments during junior and senior high school (Kahle et al., 1993, as cited in Fancsali, 2003). These differences can have serious ramifications for girls' in terms of their postsecondary education and career choices. (Fancsali, 2003, p. 2)

Rationale for the Fourth Research Question

The fourth question examined whether or not ethnicity played a role in factors that motivated youth. The necessity of this question arose from observations of robotic participants and their adult volunteers.

Rationale for the Fifth Research Question

The fifth question addressed how the participants defined success. What did it mean for participants to be successful? Measuring success is an easy thing to do if the expectations and benchmarks are already set. In the absence of such benchmarks, it is necessary to discover participants' views on success.

Rationale for the Sixth Research Question

The fifth and final question sought to identify the role of administration in promoting robotics. In a downward economic cycle what motivated administrators to place an emphasis on robotics? Robotics is a somewhat costly endeavor; thus identifying the gains associated with robotics is necessary to continue the program.
Interviewing proved to be especially effective with the 4-H youth given their access to technology and the "reality-TV" world in which they live. According to Fontana and Frey (2005), "Interviewing has so pervaded popular media that we have become the 'interview society,' where everyone gets interviews and gets a moment in the sun" (as cited in Merriam, 2009, p. 87).

Setting of the Study

This study was conducted in two MSU county Extension Service offices, representing two distinct 4-H robotics clubs. The first county Extension Service office, Shelby, is located in the central part of Mississippi. The second county Extension Service office, Henderson, is located along the Mississippi coastline. These two counties were selected for several reasons. Among them, both counties had active participation in the robotics club and other robotics events. Shelby County was the first county to adopt the robotics program in 2009; thus the youth, 4-H agent, and volunteers had a longer history from which to draw their narratives. Further, this county was unique in that it had a lower socioeconomic status and one of the highest high school dropout rates in the state of Mississippi. The second county, Henderson, was unique in that eight of the participants were homeschooled youth. These two counties were selected because they represented the span of the robotic program's reach amongst 4-H youth. Both counties had newer members that were in elementary school and older, as well as high school students that had participated for 2 or more years. Both had very active volunteers and dedicated 4-H agents that had been present in the community for many years. Shelby County is roughly a 2-hr drive from MSU, while Henderson County is 4-hr drive from the MSU campus. The initial interviews and observations were conducted at the local County Extension Service office. However, follow-up interviews were conducted via videoconference. Videoconference (rather than e-mail) allows the researcher to see the respondents' posture, hear their intonation, and observe their nonverbal cues. However, Merriam (2009) stated that "each form of computer-mediated communication has a unique effect on the information it transmits" (p. 158). Further, she argued that "this discrepancy between real and online personalities occurs even when people are trying to be themselves – or at least an idealized version of themselves" (Merriam, 2009, p. 160). Merriam also raised the idea that the technology tool could in actuality shape the tasks due to inherent biases that may be too subtle for the researcher to realize: "That is, they make some things easy to do, others difficult or impossible. It should come as no surprise that those things that the affordances make easy are apt to get done, those things that the affordances make difficult are not apt to get done" Norman (1993, as cited in Merriam, 2009, p. 160). This is an understandable concern; videoconferences are dependent on network connectivity and the availability of resources. Fortunately, every Extension Service office is equipped with the same videoconference system and participants have previous experience utilizing the technology. The videoconference system uses a high-speed Internet connection, and according to Mann and Steward (2002), "One advantage of using the Internet for qualitative studies is that it allows researchers to conduct interviews in remote areas of the world, while sitting in their offices, have day-to-day synchronous and asynchronous communication, and speak with individuals who may not be able to participate in face-to-face interviews because of physical barriers or protection issues" (as cited in Marshall, & Rossman, 2011).

General County Demographics as Compared to 4-H County Demographics

Shelby County sits several miles off Interstate 20 in central Mississippi. It had a population of 21,838 (Census, 2000); 65% of the county is Caucasian, 30% African American, 4% Native American, and less than 1% were other races. The median income for a household in Shelby is $28,735 whereas the per capita income for the county was $14,008, meaning that nearly 20% of the population was below the poverty line. The county operated on a yearly budget of $14,600, excluding salaries. Of that $14,600, $1,000 was allocated to 4-H. Shelby had a 4-H enrollment of 4,951 youth. Thus, the county could spend $4.95 on each youth for the year. The building was an older facility situated in the old, downtown section of the county seat located between a grocery store and the city jail.

Roughly 47% of Shelby County's 4-H youth are Caucasian, 51% are African-American, 0.02% are Native American, and 0.0047% are Hispanic while the remaining 1.93% are not categorized. The office consists of a county director, office associate, an Extension Family Nutrition Education Program associate, and two 4-H agents. Shelby County has a large livestock presence; thus they have a "livestock" 4-H agent as well as an agent whose focus is on youth who do not participate in livestock projects and competitions. The latter is the 4-H agent that will be a part of the study. All of the office staff are female.

Henderson County is located along Interstate 59 and has faced a great deal of challenges in recent years due to Hurricane Katrina. The landscape is changing rapidly due to the influx of people leaving Louisiana in the wake of Hurricane Katrina. Currently, it has a population of 57,000 (Census, 2000); of that, 86% are Caucasian, 12% are African American, 1.4% are Hispanic, and the remaining are Asian, Pacific Islander, or other. The median income for a household in Henderson is $30,912 while the per capita income is $15,160. Roughly 18% of the population is below the poverty line. Henderson is only slightly more affluent than Shelby although there is a greater disparity in the racial makeup of the population. The county operates on an annual budget of $33,412, excluding salaries. The discrepancy between Shelby ($14,600) and Henderson ($33,412) is due to the fact that the board of supervisors allocates more monies for the Extension Service. In the wake of Hurricane Katrina, Henderson has had more opportunities for grants and government assistance. The average operating budget of Henderson 4-H is $10,000.

Henderson has a 4-H youth enrollment of 742 youth in the county; thus Henderson can spend roughly $13.47 per child in a fiscal year. Of those 742 youth, 82% are Caucasian, and 18% are African American. While roughly reflective of the population of Henderson, it is much different than Shelby County. The office sits off from the main highway in a building approximately 50 years old that also contains the Family Court. The county staff includes a part-time county director (shared with another county), two office associates, a program assistant, an area agent, and the 4-H agent.

4-H Youth Demographics of Henderson and Shelby County

The participants in this study were 16 youth currently enrolled as 4-H members. Ten youth were selected from Shelby County and 10 youth from Henderson; however, not all youth were able to participate in the study. Of the youth participants represented in the study, 4 are African American, none are Asian, and 12 are Caucasian. According to the 4-H end-of-year report (also known as the ES-237 report), there were 48,454 African American youth, 673 Asian, 53,470 Caucasian, 411 Native American, and 1,614 Hispanic 4-H youth in Mississippi. Therefore, the sample in this study is not comparable and does not adequately represent the population of Mississippi youth enrolled in 4-H. However, it does represent the breakdown of youth engaged statewide in 4-H robotics. Additionally, there are 13 male students and 3 female youth in the study. Statewide, there are 50,376 male students and 54,246 female youths in 4-H. Therefore, the sample in this study is not representative of the population of Mississippi youth enrolled in 4-H.

The participants in this study represent a variety of grade levels and attend a mixture of public and private schools, while several are homeschooled. Of the participants, five attend public school, one attends a private school, and 10 are homeschooled. No formal records are kept at the state level that indicates the percentage of 4-H youth in Mississippi that attends public, private, or are homeschooled. The grade level of the participants represents a broad spectrum with one youth participant in fourth grade, three youth participants in sixth grade, four youth participants in seventh grade, one who stated that they were between the ninth and tenth grade (homeschooled), one youth in the ninth grade, two youth in the tenth grade, one in the eleventh grade and three in the twelfth grade.

Participants were selected for the study based on their counties. This is what Merriam refers to as “purposeful sampling.” Purposeful sampling assumes that the researcher desires to “discover, understand, and gain insight and thus must select participants from whom the most can be learned” (Merriam, 2009, p. 77). Further, these participants meet the criteria that stand the greatest chance of yielding information-rich cases. The criteria for the selection of these participants was that they participated in robotics club meetings, attended the robotics kick-off, have had robotics workshops in their county, and participate in 4-H robotics contest.

4-H Agent and Volunteer Participant Demographics

Additionally, the 4-H agents for each county and the county robotics teams’ volunteers (both adults) were asked to participate in the study. Their input provided another perspective when trying to identify factors that influence motivation in their youth. These 4-H agents and volunteers work closely with the youth, their families, their schools, and their churches in the local community and will provide pertinent information that may help develop a more clearly defined explanation of the motivational process. In this study, one of the 4-H agents is an African American female and one is a Caucasian female. Statewide, there are 18 African American 4-H agents and 61 Caucasian 4-H agents at the time the study was conducted. There are 20 male 4-H agents and 59 female 4-H agents in the State. However, in this study no male 4-H agents are represented.

Furthermore, two adult volunteers in the study are African American and six are Caucasian. There were four male volunteers and four female volunteers that participated in the interview. Statewide, there were 1,698 African American volunteers and 5,982 Caucasian volunteers; of these volunteers, 3,487 were male and 4,193 were female. Therefore, the representative sample in this study is comparable and adequately representative of the population of Mississippi 4-H volunteers.

4-H Stakeholder Participant Demographics

In addition to the youth participants, 4-H agents and 4-H volunteers, this study sought individuals who had a vested interest in 4-H and the robotics program but are not intimately acquainted with the youth or adult volunteers themselves. They were asked to provide feedback on the results of the study (results of the youth, 4-H agents, and 4-H volunteer data) and to provide their own observations of the youth involved in the program and any motivating factors therein. These two stakeholders were the state 4-H leader, and the former department head of Computer Applications and Services for ten years.

- State Program Leader: a 55-year-old African-American male with 25 years of experience
- Former Department Head, Computer Services: a 65-year-old Caucasian male with 30 years of experience who provided initial financial support of the robotics program

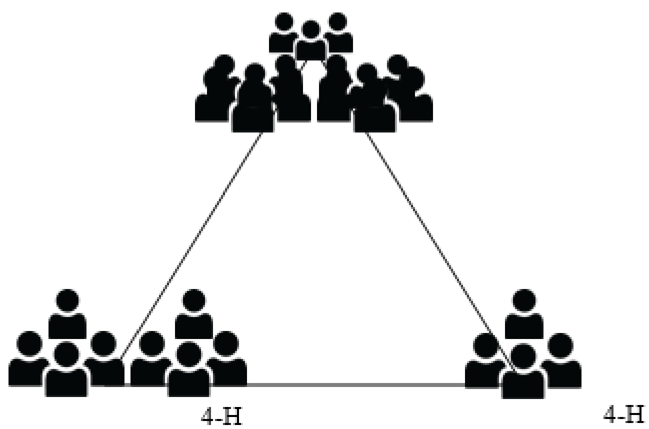


Figure 2. Data triangulation

Purposeful sampling was necessary to gain a clear understanding of the factors that influence motivation. This group had shown perseverance in continuing with the robotics project over time. By studying these groups, key factors were discovered that may be incorporated into lesson planning, activities, engagement, and marketing. By utilizing three distinct participant groups (youth, agents/volunteers, and administrators), each with differing perspectives on what factors influence motivation and achievement in 4-H robotics, a more concrete, holistic mosaic emerged. The three participant groups each represented one third of the data triangulation (see figure 2).

Data Collection

Before data collection began, approval was gained from the state 4-H program leader. Upon approval, the two counties were notified and both the Extension Service county director and the 4-H agents were notified and asked to participate in the study. All parties were informed as to the nature of the research, the potential benefits of the research to their counties, districts, and state programs, and the minimal to no risk involved in the study for both the participants and their institutions.

Once the agents agreed to participate in the study, they informed their robotics clubs (youth/volunteers) of the research project and gained permission from the parents of the youth to participate in the study via the Internal Review Board (IRB) consent form (see Appendix C). Interviews were arranged at the various county offices and homes of interview participants. Most of the interviews with the youth lasted between 30–45 minutes while interviews with the adults routinely ran 45 minutes to an hour. Two sets of interviews were conducted at the local County Extension Service office while one set was conducted at the home of a volunteer. Administrators were interviewed on the MSU campus while follow-up interviews were conducted via desktop videoconferencing.

Prior to beginning the interview, participants were informed that participation in the research was voluntary and that they were not required to participate. Further, their answers would not be attributed to them, and there would be no consequences for their responses. Thus, they were free to respond truthfully in regards to their perceptions, thoughts, and feelings. After the initial greeting and dissemination of information pertaining to the study, they were asked to sign the participant release form. The 4-H youth had to have an adult parent or guardian sign the parental consent form. Agents, volunteers, and stakeholders were asked to sign the IRB release form as well prior to commencing the interview. Participants were informed that the information provided would be confidential and that no data could be directly attributed to them. The IRB form was placed on file with the IRB committee prior to September 15, 2011. The participant IRB forms were locked in a secure location in the researchers' office.

Interviews

According to Patton (1990),

> The purpose of interviewing is to find out what is in and on someone else's mind. The purpose of open-ended interviewing is not to put things in someone's mind but to access the perspective of the person being interviewed. We interview people to find out from them those things we cannot directly observe. (p. 278)

Interviews were conducted with 4-H youth, agents, volunteers, and stakeholders to gain a better understanding of the process by which 4-H youth are motivated to pursue robotics. By interviewing participants, the researcher gained a better understanding of the participants' mental processes, their attitudes toward the program, and the reasons or impetus they had for going forward or continuing in robotics. Patton (2002), believed that we interview people to find out things that we cannot directly observe. He stated that

> we cannot observe feelings, thoughts, and intentions. We cannot observe behaviors that took place at some previous point in time. We cannot observe situations that preclude the presence of an observer. We cannot observe how people have organized the world and the meanings they attach to what goes on in the world. We have to ask people questions

> about those things. The purpose of interviewing then, is to allow us to enter into the others person's perspective. (399-400)

As this study pertained to the motivational factors that influenced youth and the adults who support them, interviews were indeed the only way to gain an understanding of the mental processes they have gone through to reach the point they are at now. The questions were designed to reveal the participants' perspectives, thoughts, feelings, and intentions. The questions were written by the researcher based on observation during the pilot year, a review of the literature and in conjunction with the dissertation advisor; see Appendix A for a list of the research questions. At the beginning of the interview, the researcher attempted to establish a rapport with the participant and ensured that the participant is comfortable in the environment and with the nature of the research study. Some of the younger interviewees were quite nervous about the process. After signing the IRB forms the youth told his mother that he thought he had, "signed his life away." Interview questions began by basic demographic information:

1. How old are you?
2. What grade are you in?
3. Where do you go to school?

Once the demographic questions were answered, the researcher guided the participant through a series of structured and semi-structured questions using the interview guide. According to Patton (1990),

> The advantage of an interview guide is that it makes sure that the interviewer/evaluator has carefully decided how best to use the limited

> time available in the interview situation and lends itself to group interviews because it forces focused interactions. (p. 283)

The interviews were audio recorded, so they could be transcribed after the interview and used during the analysis phase. Interviews that were conducted through the videoconference system were both audio and video recorded. Although some structured questions were asked, the researcher utilized a semi-structured approach to follow up on points of interest introduced by the participants. The questions were taken from the major research questions that arose from the literature review. Notes were also taken during the interview, so the researcher could detail reactions to the participant's interview. Once the interview was completed, the researcher showed the participant the contact information listed on the consent form in the event that the participant needed to contact the researcher or if the participant had concerns.

Interviews with agents, volunteers, and administrators were conducted in much the same way. Agent and volunteer interviews were conducted at the county Extension Service office and recorded so that they could be transcribed at a later point in time. All interviews were expected to last a minimum of 30 minutes and followed the same structured, semi structured format as those of the youth. However, the questions were modified to reflect the participants' roles in the robotics program. The questions were devised by the researcher based on issues that arose from the literature review. These questions were approved by the dissertation chair. No incentives were offered to participants for agreeing to participate in this study.

Interviews with stakeholders took place at the researcher's office. The office is housed in the Extension Service building, situated on a major university campus in

Mississippi. These forms were presented at the time of the interview, and the stakeholder participant was informed as to the nature of the study and his or her part in the study. Stakeholders were asked to sign the consent form. Additionally, stakeholders were asked to reflect on the data gathered from youth, agents, and volunteers.

Observation

Observation took place over the course of a 12-month time span during which the researcher was able to observe the participants in various settings. These settings include contests, workshops, camps, and special events. Observations, according to Merriam (2009),

> should take place in the setting where the phenomenon naturally occurs instead of a location designated for the purpose of interviewing; second, observational data represents a firsthand encounter with the phenomenon of interest rather than a secondhand account of the world obtained in the interview. (p. 117)

Observations also provided context for the interview and allow the researcher to ask more probing questions. This fieldwork was recorded in a journal. The journal recorded the three stages of researcher observation: entry, data collection, and exit.

Document Collection

Documents can provide an invaluable source of information to the researcher. The documents that were requested and investigated are the county budget sheets, the county ES-237 reports, newspaper articles, club meeting rosters, youth videos, Facebook posts on the robotics page, e-mails, photos, 4-H agent newsletters, flyers, and 4-H record books. Documents, although not a realistic view of the situation, do provide insights into what participants regard as important or edifying. Documents allow us a “snapshot” into the participants’ minds and reveal their personal perspectives of everyday events (Merriam, 2009, p. 142).

Artifacts

According to Merriam (2009), “because physical traces can usually be measured, they are most often suited for obtaining information on the incidence and frequency of behavior. They are also a good check on information obtained from interviews and surveys” (p. 148). The artifacts in this research consist of the robot, completion toward building and programming the robot, stress on the motors, number of pieces missing from the kit, and so forth.

Data Analysis

Data analysis in a case study can often be overwhelming for the researcher due to the sheer volume of material to analyze. In order to manage the data collection and in order for the data analysis to flow more smoothly, a case record was compiled and indexed so that data could be retrieved more easily. Initial themes or categories were established based on the research questions; however, other themes may emerge from the interviews, observations, documents, and artifacts. A five-step process for analyzing the data was used. It included (1) listening to the tapes and transcribing them, (2) reading and re-reading the transcripts over time to become familiar with the data, (3) coding each interview for common themes, (4) summarizing the coded data and (5) writing an interpretation of the data (Yin, 2009).

After each interview, the tape was transcribed and reexamined in order to discover emerging themes and to determine if follow-up questions were warranted. The interviews were examined in conjunction with the researcher's notes to highlight the participants' responses. After all of the interviews have been transcribed and reviewed, they were re-read and common words and phrases were identified to indicate possible themes. These terms included fun, future, teamwork, winning, and doing our best. These segments, or units of data, can be as small as a word a participant uses to describe a feeling or phenomenon, or as large as several pages of field notes describing a particular incident (Merriam, 2009, p. 176). Further, the unit should be the smallest piece of information that can stand by itself (Guba, 1978, as cited in Merriam, 2009, p. 177).

Upon completion of the data organization, an inductive analysis was conducted. Patton (1990) said of this type of analysis, "Inductive analysis means that the patterns, themes and categories of analysis come from the data; they emerge out of the data rather than being imposed on them prior to data collection and analysis" (p. 390). This analysis is guided by the research questions identified in the literature review. Themes, patterns, and categories were identified and noted in the transcribed data and were coded so that a data index could be created. The researcher utilized the constant comparative method (Merriam, 2009) in both the initial interviews and the subsequent follow-up interviews to identify categories of consistency among the responses and latency between interviews that revealed changes of attitude over time. The data were broken down into groups based on their participant category, youth, agent/volunteer, and stakeholder. As themes began to emerge they were placed together by theme but still separated by participant group. Lastly, the themes and data were examined to determine how they contributed to developing an answer to the research questions posed.

In addition to the interviews, the 4-H record books of participants were reviewed as well. The record books are a journal of sorts that 4-H'ers keep up with over the duration of their time in 4-H. It includes all of their projects in addition to robotics. It is interesting to examine how the 4-H'ers write about robotics as compared to their other projects.

Issues of Rigor

In order to ensure that these data are trustworthy, they must be exposed to a rigorous system of checks and balances so that readers may assured of the credibility of the transferability of the data. In their work entitled *Naturalistic Inquiry* authors Lincoln, & Guba (1985) put forward procedures to ensure the validity, reliability, objectivity, and generalizability of research. These procedures included:

1. Prolonged engagement in the field to ensure validity and reliability;
2. Member checks to share data and verify interpretations with participants;
3. Triangulation of the data obtained from multiple interviews, observations, documents, and artifacts; and
4. Peer checks to enable the researcher to go over findings with colleagues to ensure analysis is grounded in the data. (as cited in Marshall & Rossman, 2011, p. 40)

Maxwell (2004) also added to the discussion of rigor by including the need for the researcher to include rich descriptions of the data, quasi statistics to assess the amount of evidence, and comparison. Later authors, such as Cresswell and Miller (2000), added searching for disconfirming evidence, audit trail, and peer debriefing. Drawing from these researchers, the following criteria was used to ensure the rigor of this study: credibility, triangulation, member checks, dependability, audit trail, transferability, and rich, thick description.

Credibility

According to Patton (2002), the credibility of a qualitative report depends on the rigorous methods of fieldwork, on the credibility of the researcher, and on the fundamental appreciation of naturalistic inquiry, qualitative methods, inductive analysis, purposeful sampling, and holistic thinking. Credibility in this study has been established by a careful delineation of the procedures that defined and guided this study and have been explained in previous paragraphs. Each component of the case study has been examined and categorized based on the initial research questions and those themes that emerged during the course of the study. Additionally, those themes have been cross-referenced with one another to see if any other relationships exist. The constant comparative method was utilized to discover similarities and differences between data sources.

Triangulation

Triangulation is used to ensure the transferability of qualitative research. According to Denzin there are four types of triangulation, "triangulation involves the use of multiple sources of data, multiple methods, multiple investigators, or multiple theories" (1978, as cited in Merriam, 2009, p. 215). Built into the study before data collection begins, triangulation enables the researcher to assert that his or her interpretations of the data are credible (Marshall & Rossman, 2011). Triangulation was achieved in this study through the use of multiple input sources (interview participants, observations, documents, and artifacts). The interviews themselves included triangulation in that youth, agents, volunteer, and stakeholders were interviewed for the study. This also means a broader, more holistic understanding of the process by which 4-H'ers are motivated to participate in robotics can be discovered. Research questions may not be answered by the interviews alone either. In addition, observations at various events, of various interactions, and of various people contributed to the identifications of themes within the data. Triangulation was achieved by interviewing a variety of participants based on age, gender, race, schooling, and location in addition to utilizing different sources.

Member Checks

Member checks are yet another way to ensure transferability within the study and involve taking the transcribed material as well as the interpretation of the participants' comments back to them and having them verify that the researcher's interpretations were accurate. According to Maxwell (2005, as cited in Merriam, 2009), "this is the single most important way of ruling out the possibility of misinterpreting the meaning of what participants say and do and the perspective they have on what is going on; it is also an important way of identifying a researcher's own biases and misunderstandings of what he or she observed" (p. 217). Once the interviews were transcribed, they were reviewed; if during that process something the participant said was unclear, he or she was telephoned or emailed and asked to clarify the remarks.

Dependability

According to Merriam (2009), "qualitative researchers seek to describe and explain the world as those in the world experience it whereas quantitative researchers study a single reality that should when studied repeatedly yield the same results" (p. 220). Qualitative research studies cannot be replicated because human nature is not static, nor do human experiences in the world stop simply because a lone researcher wishes to conduct a study. However, the more important question for qualitative research is, "whether the results are consistent with the data collected" (Merriam, 2009, p. 221). Lincoln and Guba (1985) felt that reliability in qualitative research was better described as dependability or consistency given that another researcher with the same participants would yield the same results as the first researcher. By utilizing a triangulation as well as an audit trail, the researcher can ensure dependability in the study.

Audit Trail

An audit trail reveals to the reader how the researcher arrived at his or her results. The audit trail consists of a journal or log of the researcher's activities, how data was collected, perceptions, reactions, how themes emerged from the interviews, documents, observations, and interviews. A journal was kept at the onset of the research study to detail the movements and activities of the researcher in rich detail.

Transferability

In quantitative research, generalizability refers to the external validity of the study and the degree to which the findings can be applied to another situation. This is done through a series of a priori conditions, which assumes the sample is representative of the population. In contrast, qualitative research focuses on a small, nonrandom sample that the researcher wants to study in depth (Merriam, 2009, p. 224). Lincoln and Guba (1985) argued that rather than using the term *generalizability*, we should use the term *transferability*. Transferability in this qualitative research study means that readers can take the findings and determine to what degree they can apply it to their situations. According to Lincoln and Guba (1985), "the original inquirer cannot know the sites to which transferability might be sought, but the appliers can and do. The investigator needs to provide sufficient descriptive data to make transferability possible" (as cited in Merriam, 2009, pp. 234–345). In order to ensure transferability, triangulation and rich, thick data description was used.

Rich, Thick Description

Rick, thick description is the backbone of qualitative research and, as such, holds a prominent role in the research study. Maxwell (2005, as cited in Merriam, 2009) refers to this as a highly descriptive, detailed presentation of the setting and the findings of the study. Rick, thick description also includes direct quotations from participants in the study, field notes, and documents. By utilizing rich, thick description to describe the details of the study, readers will be able to determine the degree to which the findings can be transferred to their situations.

Ethics

Because the researcher is the primary instrument of data collection, the issue of ethics is of paramount concern. As the research, I had to articulate any biases that might impact the study and account for them accordingly. Furthermore, all procedures and guidelines set forth by the IRB were strictly adhered to. The participants in the study received an IRB consent form, which they were asked to sign and then placed in a secure location. The names of the participants will be held in confidence, and their responses to interview questions will not be linked back to them.

Limitations

The most obvious threat to this study comes from the sample selection. As there is such a small population to sample from to begin with, every effort was made to insure that demographics of the sample reflected the population. Also, many 4-H agents may in some way feel threatened and may negotiate the responses to reflect what they feel administrators want to hear, the information given may not be as trustworthy as it could be if coming from a completely anonymous source.

Location threat is of secondary concern as most Extension Service offices are funded at the county level. Obviously, some counties are more affluent than others, which impacts not only their physical environment but to some extent the participants' outlooks on their particular situations. Some counties receive more money from local supervisors and are, therefore, better able to afford equipment, materials, travel, and so forth. However, other counties operate within a very tight budget framework and may not be able to provide the same infrastructure to their 4-H'ers.

Additionally it was imperative that the researcher identifies any bias on her part so as not to skew the questions asked or the responses given. There is a perception in the Extension Service organization that there exists a gulf between the way that county-level employees view their work and the way state-level employees perceive the work of the county 4-H agents. In the Extension Service, it is referred to as "the ivory tower" mentality by the county agents. As the researcher was from the bastion of the "ivory tower" to the "frontlines," it was essential that all conceptualized biases be noted and addressed.

Summary

This chapter provided an overview of the methodology that was employed when conducting this research study. It included a discussion of design of the research, the rationale for using a case study, the setting of the study, a detailed description of the participants, the procedures by which data were collected and analyzed, and the steps by which rigor was established and maintained. Engaging participants in this study provided a transparent look into behaviors, ideas, and social constructs that impact the motivation of 4-H youth engaged in the robotics program.

CHAPTER IV

RESULTS

Introduction

The purpose of this case study was to investigate factors which influenced the motivational attributes of participants engaged in two Mississippi 4-H robotics clubs. Understanding the factors that motivate youth, volunteers, 4-H agents and administrator who participate in robotics programs is critical to developing a program that engages participants long-term. Studies, such as Nugent & Barker, 2009, and Jewell, 2011, attempted to assess whether or not students' attitudes towards science are affected by the implementation of robotics into the learning environment. Most of these studies make the assumption that robotics is motivating (Mataric et al., 2007; Rogers & Portsmore, 2004), due to its background in constructivist educational theory. Unfortunately, this assumption does little to reveal the underlying motivational factors that engage participants in the robotics project. The six research questions that guided the study were:

1. Are 4-H youth intrinsically or extrinsically motivated to participate in robotics?
2. What motivates volunteers to help 4-H youth participate in robotics projects?
3. Are the factors that motivate 4-H boys different than that which motivates 4-H girls?

4. What role if any does ethnicity play in the motivational attributes of 4-H'ers, volunteers, agents, and stakeholders?
5. What is the role of varying factors of motivation in success? What does "success" in the robotics project mean for the youth, agents, volunteers, and stakeholders?
6. What role do administrators have in promoting robotics, and how are those efforts perceived by youth, volunteers, and staff at the county level?

The data collected in this study provided a framework from which to understand the phenomenon that influences participants to engage in the robotics program. A total of 16 youth, two 4-H agents, 8 volunteers, and two state-level administrators participated in this study. The youth, agents, and volunteers represented two unique counties in the State of Mississippi with a diverse background and provided valuable insights. After all of the data were collected they were divided into themes, and then separated into the four participant groups interviewed in the study, 4-H youth, their volunteers, 4-H agents, and Extension administrators to form a case study database (Merriam, 2009). The methodology described in chapter three of this research yielded an analysis of the documents in the database. Once the analysis was conducted the following findings emerged and have been grouped into general themes based on the research questions or common factors that multiple participants voiced (see Table 1).

Table 1

Summary of Themes and Findings from Data

Themes	Findings
Intrinsic motivational factors *(Corresponds to Research Question 1)*	a. Internal desire and determination of the participants to finish or complete tasks. b. The belief participants hold that robotics is simply something "fun" to do.
Extrinsic motivational factors *(Corresponds to Research Question 1)*	a. Participants noted that building the robot was a motivational factor. b. Participating in robotics contests. c. Working together as a team and finding a place to belong. d. Planning for their future and seeing robotics as a means to future success.
Motivational factors that influence volunteers to support the robotics program *(Corresponds to Research Question 2)*	a. Engaging youth in positive activities. b. Creating a future for their youth. c. Encouraging youth to persist in the face of difficulties or obstacles.
Factors that motivate female youth versus male youth *(Corresponds to Research Question 3)*	a. Perception of gender roles. b. Overcoming gender barriers.
Ethnicity as a motivational factor *(Corresponds to Research Question 4)*	a. Ethnicity/race was not viewed as having any impact. b. Questions pertaining to ethnicity/race were assumed to have a negative connotation. c. Participants equated questions of race to negative sportsmanship.
Success as a motivational factor *(Corresponds to Research Question 5)*	a. Defining the individual's perception of success. b. Teamwork as variable to success. c. Ability to resolve conflict within group. d. Envisioning the end result or goal. e. Viewing robotics as means to achieve personal dreams.
Role of administrators in promoting Robotics *(Corresponds to Research Question 6)*	a. Participants view 'administrators' as the State-level robotics instructors. b. Administrators view role as supporting and securing funding.

These findings emerged from the participants' own words as well as from the observations and review of artifacts. They provided an understanding of the motivational factors that worked together to engage participants in the robotics program. All of the themes indicated factors that 'energize and activate' robotics participants. For Ryan and Deci (2000) to be energized and activated toward an end is to be motivated. These themes worked together to form a holistic representation of the internal workings of the participants. Getting to the root of motivation is imperative, for as Ryan and Deci (2000) stated,

> To be motivated means to be moved to something. A person who feels no impetus or inspiration to act is thus characterized as unmotivated, whereas someone who is energized or activated toward an end is considered motivated. Most everyone who works or plays with other is, accordingly, concerned with motivation, facing the question of how much motivation those others, or oneself, has for a task, and practitioners of all types face the perennial task of fostering more versus less motivation in those around them. (p. 54)

Discovering the driving factors behind motivation is critical to engaging youth in the robotics project. Unfortunately, motivation is difficult to measure especially when dealing with children who may not be able to delineate those factors which motivate them clearly. Thus, a qualitative approach was important to understanding the factors that 'energize and activate' robotics participants to become involved in the robotics project.

Research Question 1

Intrinsic Motivational Factors that Influence Participants

Are 4-H youth intrinsically or extrinsically motivated to participate in robotics? The first part of the research question involves intrinsic motivation whereas the second part deals with extrinsic motivation. These two types of motivation are at the core of what motivates participants,

Intrinsic motivation, according to Ryan and Deci (2000) is,

> defined as the doing of an activity for its inherent satisfactions rather than for some separable consequence. When intrinsically motivated a person is moved to act for the fun or challenge entailed rather than because of external prods, pressures, or rewards. (p. 56)

Intrinsic motivation as long been considered by the educational community to be a more authentic form of motivation as it originates within the person and is a driving force to the realization of the individuals' goals.

Of the 14 youth interviewed for this study, all identified robotics as a project in which they chose to participate voluntarily. As one 18 year-old male stated about his participation in his county's robotics club, "It's definitely my choice. As much as I do in 4-H, my parents don't push me to do anymore activities…so, it's really what I do now is pretty much my decision, so robotics is my choice to do." A female youth, who was 15 at the time of the interview, took ownership of her participation in robotics, "at first my mom was like you should go try it out but now it's my, my choice to do it." This sentiment was echoed again by another 18 year old female youth,

> I definitely think it's my choice. There are so many things to do in 4-H, you can pretty much choose anything but I love robotics so much that it's not even like I have to…people may be like you should but I'm like I'll think about it but ultimately it's my choice to participate in robotics.

> Kinda within you, cause you gotta have that motivation and if you don't have it, you're not going to be excited about it, nobody else is going to be excited about it. As much as people can be like oh, it's so much fun you're not really crazy about it or want to do it, you're not going to feel that enthusiasm. So, I think it has to come from within.

The older youth were clearly able to define their desire to participate in robotics whereas younger participates generally stayed with one word descriptors such as 'fun'. Older youth identify this desire as something that they choose to do of their own volition. However, the adults that work with the youth recognize other attributes of the youth that they believe influence their intrinsic motivation.

Desire and Determination as an Intrinsic Motivational Factor

When a 44 year old mother of two talked about what motivated her children, she said it all begins with an internal desire,

> First of all, first thing, you have to have the desire; you have to want to do it. Next you gotta make sure you are here. You have to be at the meetings, to know what is going on, then you got to have someone that's behind you pushing you telling you that you can succeed at this, but you first of all you have to want to do this. I can want you to do it all day long, but if you

> don't want to do it you're not going to succeed at it. So, that's the first step, you have to have the desire to do it. That's what I think.

Ryan and Deci (2000) would agree with the perceptions of this mother, according to the researchers:

> In humans, intrinsic motivation is not the only form of motivation, or even of volitional activity, but it is a pervasive and important one. From birth onward, humans, in their healthiest states, are active, inquisitive, curious, and playful creatures, displaying a ubiquitous readiness to learn and explore, and they do not require extraneous incentives to do so. This natural motivational tendency is a critical element in cognitive, social, and physical development because it is through acting on one's inherent interests that one grows in knowledge and skills. The inclinations to take interest in novelty, to actively assimilate, and to creatively apply our skills is not limited to childhood, but is a significant feature of human nature that affects performance, persistence, and well – being across life's epochs. (Ryan & LaGuardia, 2000, as cited in Ryan & Deci, 2000, p. 56)

This natural tendency towards performance and persistence was noted by a 4-H agent when discussing her youth. Of the youth she said,

> They are very driven and they want to do the top-notch in anything they do. I think it's, I won't say they don't want to have fun but they are very interested in being the best in everything they do. I think the intensity comes from them wanting to get everything just right and participating in all aspects of it.

Further, she recounted an experience she had with her youth at the State Fair Robot Round-Up. The Robot Round-Up is held at the Mississippi State Fair in Jackson, Mississippi. Every October, the State 4-H office hosts the 4-H Village as well as the State Livestock shows at the Mississippi State Fair. As part of this event, 4-H provides booths and activities for children who attend the fair. For the past two years, the robotics program has hosted a 'livestock' competition as well. Youth build robotic animals and compete against other counties for the "best in show" award. According to this particular 4-H agent she believed that the youth in her club,

Were trying to show the others in the group and beat the other teams too. I think that was their job and motivation then was to show the other teams that they could do it. It's like when someone is there with you, it's like when you exercise too, you have accountability. You are going to want to do it longer and be on the go. It's like with robotics too because they have another team to compete and try to be the best or get it done first. But I think that even if they were the only ones there that they would still try to make it do right. At the State Fair Robot Round-up they were not really competing against another group and it wasn't a set robot or set task it was their own creativity there. I know their scorpion didn't work or whatever, he died at State Fair, she wanted to go buy more batteries for it, it wouldn't work. One of the other 4-H'ers came and tried to fix it because they wanted to show the kids that came to the State Fair how it worked. I

> think their internal motivation was they wanted to get it right. That's instilled in them how to fix it that's instilled in their parents too.

Interestingly, the interviews revealed that both teenage youth and volunteers were able to differentiate whether or not choosing to participate in the robotics program was their choice or if they were influenced from others to participate. Younger 4-H'ers simply noted that participating in robotics was 'fun'. When asked to explain what was 'fun' about robotics they looked at me with a sense of bewilderment on their faces and told me exasperatedly that robotics just *is* fun. According to Ryan and Deci (2000), "when intrinsically motivated a person is moved to act for the fun or challenge entailed rather than because of external prods, pressures, or rewards" (p. 56).

For the Fun of It – Fun as an Intrinsic Motivational Factor

The word 'fun' and its many childlike variations, such as 'funnest,' came up more times in the research interviews than any other word besides 'robot.' Whereas older youth (senior 4-H'ers who are 14-18 years old) and adults would say that robotics is fun they were then able to give supplemental information to explain why robotics was fun to them. However, younger youth (junior 4-H'ers who are 8-13 years old) were only able to identify robotics as 'fun'. An 11 year old boy said, "I think working with the robots is the most fun." According to another 11 year old male, "I like robotics because it's fun, you can learn a lot and you can have a lot of memories". Another youth said, "It's really fun if you choose to do it. You get to do all this cool stuff." While another junior 4-H'er summed up his feelings about robotics succinctly, "Since it's working with robotics, I likes it."

Adult volunteers also placed a high premium on "fun." A male volunteer said that when leading his robotics club that, "The main thing is, we want to have fun first. And when we're having fun first, then everything else falls in place." A female volunteer in the same county commented on what she observed about her 12-year-old son during a robotics competition,

> Yes, getting up and getting up in front of people, you know, I know sometimes they're nervous but it's like when they get up there and they start competing it like all of that is gone. They're just focused on what…I used to think my son was ADHD to a point, you know…but when he do robotics he, it's like a calmness, and its challenging but he's having fun. And I love to see those children having fun.

The word 'fun' had a different connotation for one State-level 4-H administrator. He described fun in the context of the atmosphere created by the staff that orchestrates the robotics program, of the staff he said,

> Those individuals, you look at them and how these are the ideal personalities you want surrounding young people because they are like a magnet. They just draw kids to them. First of all they are very knowledgeable in what they do. The other side of that I see them making it fun and not being critical. If something they do doesn't work they don't say "Oh, that's not right!" They basically say, "Wait. Let's try it this way." So it's like the kid doesn't feel intimidated by getting it wrong. They feel relaxed. I didn't realize the impact those individuals would have working with the kids. I had to see it myself.

The interviews suggested that the concept of 'fun' has a trickledown effect which inspires the intrinsic motivational factors that influence participants to take part in the robotics projects.

Extrinsic Motivational Factors That Influence Participants

While intrinsic motivation is considered to be the best form of motivation, Ryan and Deci (2000) believe that there can be value in extrinsic motivation as well,

> Students can perform extrinsically motivated actions with resentment, resistance, and disinterest or alternatively, with an attitude of willingness that reflects an inner acceptance of the value or utility of a task. In the former case – the classic case of extrinsic motivation – one feels externally propelled into action; in the later case, the extrinsic goal is self endorsed and thus adopted with a sense of volition. (p. 55)

Robotics, by definition, is a constructionist activity. Constructionist theory is, according to Papert (1993),

> Built on the assumption that children will do best by finding ('fishing') for themselves the specific knowledge they need; organized or informal education can help most by making sure they are supported morally, psychologically, materially, and intellectually in their efforts. The kind of knowledge children most need is the knowledge that will help them get more knowledge. (p. 139)

Furthermore, Papert (1980) argued that,

> In most contemporary educational situations where children come into contact with computers the computer is used to put children through their

> paces, to provide exercises of an appropriate level of difficulty, to provide feedback, and to dispense information. The computer programming the child. In the LOGO [pre-cursor to LEGO® Mindstorms] environment the relationship is reversed: The child, even at preschool ages, is in control: The child programs the computer. And in teaching the computer how to think, children embark on an exploration about how they themselves think. (p. 19)

When a child is able to take an object that exists in their environment and construct a new idea, concept or object, they are participating in a constructionist learning environment. The LEGO® Mindstorms NXT robot offers an obvious extrinsic motivation to young learners as it allows them to see a physical manifestation of the structures created in their imaginations.

Building the Robot as an Extrinsic Motivational Factor

While many participants are intrinsically motivated to participate in the robotics project, extrinsic motivation plays an equally important role. According to the constructivist theory upon which the robotics platform was built, the act of building the robot is the motivational driver that influences participants. The robotics project consists of two fundamental activities; building the robot and programming the robot. Of the two, participants consider building to be the 'funnest' and the easiest part of working with the robot. According to a 10-year-old male participant interviewed for this study, "I like the part where you get to build the robots. That is the funnest part." In all but one instance building took precedence over programming. Another participant, a 15-year-old female said, "I really like building the robots and then seeing how they move and stuff." One

10-year-old male participant said his favorite part was, “building those awesome robots.” While building was considered a major factor for all participants, one extrinsic factor stood out far above the rest, competition.

Finding Extrinsic Motivation in Contests

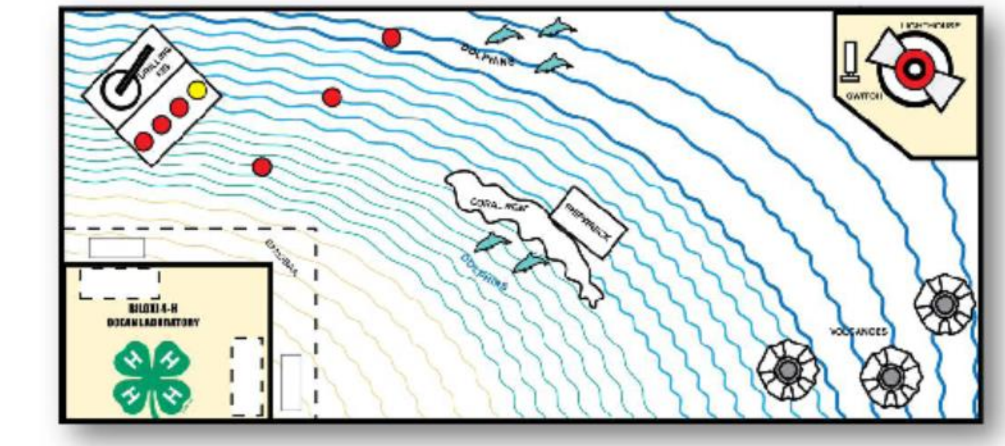
Competition proved to be an extremely important extrinsic motivational factor for the participants that were interviewed. In fact, one adult volunteer said if it was not for competition they thought the robotics program would die. Competition is held once a year. It allows 4-H youth that participate in robotics to gather together and showcase their robot. For the past two years a robotics competition has been held for both the senior level 4-H’ers as well as for junior 4-H’ers.

Background of Robotics Contests in Mississippi

Having observed the robotics contests firsthand, it was easy to gain a mental image of what the interview participants were talking about when animatedly discussing robotics contest. The senior robotics competition is held at Mississippi State during 4-H State Congress. State Congress is the annual three-day convocation for 4-H youth drawing over 700 youth who engage in visual presentations, judge events, and compete for statewide office. The junior robotics competition held in each of the four districts Extension divides the State into the Northeast District Project Achievement Day competition typically held at Itawamba Community College, the Southeast District Project Achievement Day competition held at Howard Industrial Park, the Southwest District Project Achievement Day held at the Hinds Community College, and the Northwest District Project Achievement Day held at Delta Community College.

Each year a new contest mat is revealed to the robotics participants in early April. The youth then have 4-6 weeks to prepare for the contest. The competition mat used during the 2010 contest centered on the youth building and programming a robot to perform certain tasks off the coast of Mississippi. Each contest mat is built around a Mississippi-related theme so that youth may learn more about the history and geography of the state.

Contest participants have roughly a month to design, build, and program a LEGO® Mindstorms NXT robot that is capable of successfully navigating the contest mat. The object is to acquire as many points as possible while avoiding penalty points (see figure 3). In the 2010 contest mat, participants were required to start their robot in the Biloxi 4-H Ocean Laboratory. Participants were only allowed to touch the robot inside the laboratory. The youth had to program the robot to run the course autonomously. Youth were given 3 minutes to complete all of the challenges on the mat. The challenges include moving protective sandbars in place, placing depth marker buoys at designated locations on the ocean floor, identifying the active volcano, transporting the lighthouse lamp from the shipwreck to the lighthouse, and turn on the lamp in the lighthouse. Participants were not allowed to damage the coral reef or hit the school of dolphins. Ironically, this contest mat was developed and released mere months before the actual BP (British Petroleum) oil spill in the Mississippi Gulf Coast on April 20, 2010. Thus the students were able to draw comparisons between their work with a robot and actual work that was taking place in the Gulf of Mexico using robots to cap the oil spill.



TEAM NUMBER: _____
ROUND: __________
REFEREE: ________

2010 ROBOTICS CONTEST MAT RUBRIC

CHALLENGE	POINTS POSSIBLE	TOTAL POINTS	PENALTY POINTS
SANDBAR #1 IN PLACE	(0 PTS)	________	
SANDBAR #2 IN PLACE	(0 PTS)	________	
DEPTH MARKERS (RED & WHITE) (30 PTS/10 PER MARKER)			
MARKER #1 IN PLACE	(10 PTS)	________	
MARKER #2 IN PLACE	(10 PTS)	________	
MARKER #3 IN PLACE	(10 PTS)	________	
ACTIVE VOLCANO MARKER (YELLOW AND WHITE)			
VOLCANO MARKER IN PLACE	(10 PTS)	________	
PICK UP LIGHT FROM BOAT	(0 PTS)	________	
DEPOSIT LIGHT TO LIGHTHOUSE	(0 PTS)	________	
TURN LIGHT ON	(10 PTS)	________	
POINT PENALTIES:			
TOUCHING THE ROBOT OUTSIDE OF THE LABORATORY (-5 PTS/PER TOUCH)			________
HITTING THE DOLPHINS (-2 PTS/PER TOUCH)			________
HITTING THE CORAL REEF (-2 PTS/PER TOUCH)			________

TEAMWORK (20 PTS POSSIBLE)
EACH MEMBER IS CONTRIBUTING TO THE TEAM? ___ x 2 = ___
1 2 3 4 5 6 7 8 9 10
RESPECTFUL AND ENCOURAGING TO OTHER TEAM MEMBERS? ___ x 2 = ___
1 2 3 4 5 6 7 8 9 10

Grand Total (Total Points – Penalty Points) = __________
Comments: __________
Judges' Signature: __________

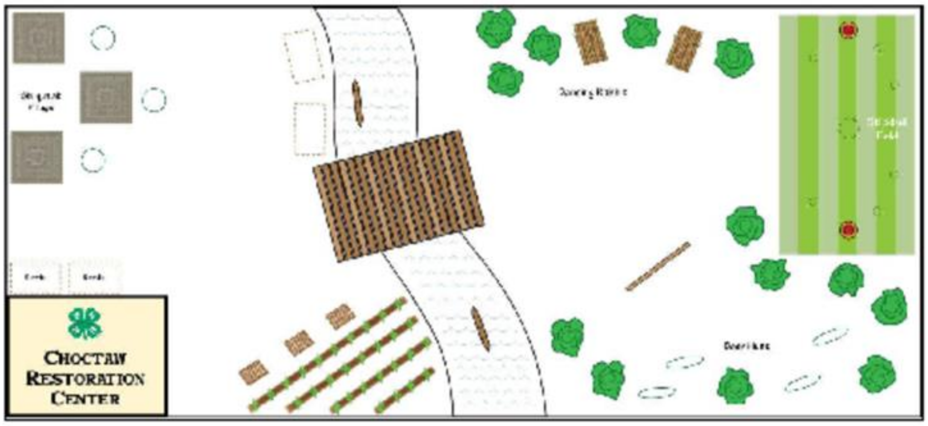
Figure 3. 2010 robotics contest mat rubric

The competition mat for 2011, the third year, focused on Mississippi's Native American heritage, in particular the Band of Choctaw Indians (see figure 4). Again, youth could only touch the robot at the Choctaw Restoration Center. Here, they could switch out a part or change the program on the robot. The robot assisted the Choctaw people with a reed restoration project. This restoration project was modeled after a project being conducted by the MSU and the Mississippi Band of Choctaw Indians. Over time the reeds used by the Choctaw Indians to make various baskets have become depleted and no longer grow abundantly along the banks of the Pearl River. The University conducted experiments to determine why the reeds were being depleted and how to best plant and sustain new reed growth near the riverbed (http://www.rivercane.msstate.edu/research/restoration/). This is an example of how the Extension Service helps to bring the resource-based knowledge of the University to the people of Mississippi. Subsequently, Mississippi youth are able to join in scientific pursuits that enrich their lives and build bridges between the theoretical and the practical.

At a more practical level, this contest theme was inspired by the fact that the LEGO® Mindstorms NXT kit comes with a spring-loaded cannon and arrow that young boys are particularly fascinated by. The boys had requested that they be allowed to "shoot" something in the contest, so shooting the deer provided them with an opportunity to build a robot that could shoot at a target. Youth had to build a robot to transport new reeds plots to the river bed, harvest corn from the fields and take baskets of corn back to the village, cross a bridge without falling into the river, shoot 3 bucks, trap two rabbits, and score a goal on the stickball field. Penalty points included running into trees, tipping over the Indian chief's canoes, shooting the doe, or injuring a stickball player.

Team Number/County:____________/__________________
Round (Circle One): PR 1 2 TIE
Referee: ______________________________________

2011 Robotics Contest Mat Rubric



Challenge	Points Possible	Total Points	Penalty Points
Reeds #1 in place by river	(5 PTS)	______	
Reeds #2 in place by river	(5 PTS)	______	
Basket #1 in place	(10 PTS)	______	
Basket #2 in place	(10 PTS)	______	
Basket #3 in place	(10 PTS)	______	
Stickball	(25 PTS)	______	
Buck #1	(5 PTS)	______	
Buck #2	(5 PTS)	______	
Buck #3	(5 PTS)	______	
Rabbit #1	(10 PTS)	______	
Rabbit #2	(10 PTS)	______	
Point Penalties:			
Touching the Robot outside of the Laboratory	(-5 PTS/per touch)		______
Hitting/running over trees	(-2 PTS/per hit)		______
Tipping over the canoes	(-10 PTS/per tip)		______
Shooting a doe/fawn	(-5 PTS/per hit)		
Hitting a stickball player	(-5 PTS/per hit)		______

Teamwork (20 pts possible)
Each member is contributing to the team? ____ X 2 = ____
1 2 3 4 5 6 7 8 9 10
Respectful and encouraging to other team members? ____ X 2 = ____
1 2 3 4 5 6 7 8 9 10

Grand Total [Total Points – Penalty Points] = ____________
Comments: ______________________________
Judges' Signature: ______________________________

Figure 4. 2011 competition mat rubric

According to participants, the robotics contest is critical to motivating 4-H participants to pursue the robotics project. A male 4-H'er (youth) said the he liked the challenge of competition and that when they had competed successfully that he had, "basically climbed the mountain and now I'm over it, I get to look at the view." Another male youth stated about competition that, "It's a drive; you have that adrenaline that you want to win. It pushes you; it's another push that makes you study." In order to "climb the mountain," participants recognize that they have to study, strategize with teammates, and work long hours to win.

Teamwork as an Extrinsic Motivational Factor

One youth said of robotics,

> I like robotics. Another really interesting fun aspect about it is like deciding what challenges to do. I remember the deer [a challenge on the 2011 contest mat]. I remember David really wanted to get the deer, he was really excited about it; that was all he could think about, just a way to complete that challenge. And I know it didn't get that many points, so I really didn't care about the deer. So I always think it's fun to look at what challenges to do and like the whole strategy of what your robot's going to complete first. The whole strategy, what's worth more points what you can accomplish. You might want to do that first and it's really fun, the whole strategy of what to do first and what to try the hardest for.

Working together to develop a strategy is critical to a teams' success in robotics. A senior 4-H male said that working with his team was the 'mental side' of preparing for robotics competition. Of his team he said,

> That's the mental side of it to start with and then you have to get a team together and you just can't pick random people, you have, really have to

> get people that you have similar opinion on, unless your good with diversity and that's a good thing, you may even get a better results, with a diverse opinion. And, you got to put your team together and you have to decide what you want to do, what you want the robot to do, in our instance we want it to run a course and run certain obstacles and that's how we designed our robot. And you got to get through the diversity of that working with confrontations and such but when you get the design of the robot it's really straightforward, your team works together, you build it, you program it, and you go to competition. But to keep that mental side very strong and positive attitude and you want to have to do this. Not just of you but the whole team, if someone starts getting out of it you have to cheer 'em up, you know and keep 'em going.

A senior female 4-H'er also said that teamwork was extremely important to robotics and a factor in her motivation. She said,

> I think it would have to be teamwork. I know I'm saying that a lot. Knowing, like I wouldn't want to let them down, they're doing all their stuff and me not doing my part. I guess that's what motivates me.

She continued by saying, "I mean, I guess, because you're always going to be with them, you're not alone, you won't get lonely talking to yourself [laughter] and, I guess, I wouldn't have to have it all of it on my shoulders, they're there to help me." A senior male 4-H'er said that teamwork was important,

> because if you just work by yourself you're not going to get a lot done, but if you have other people working on other things like working on the other

> half of the robot then it's going to go faster because all you have to do is put the pieces together and you have the robot.

A 4-H agent commented, "I think robotics is important. It teaches them to work together as a team, think things out, if it doesn't work the first time, think things out and try it again. I think that is a life skill."

Competition rubrics and judges notes reveal that the teams where the youth take ownership of the project and have a good working relationship with each other score higher than those teams where parents dictate each step for the youth. If the youth have feeling of mastery toward the robotics challenge they are more likely to internalize what they are learning and communicate that knowledge to other youth. An 18 year old female said of competition,

> I guess just the feeling of accomplishment. You know all that hard work that we had put into it and the hours that we had spent thinking oh my gosh this is never going to work and walking in there seeing all the other teams, we just felt like wow! We did, we can do this, you know?

Hotbot Points as an Extrinsic Motivational Factor

In addition to the end of year contest, there are also monthly Hotbot point challenges for the youth to complete. Each month the clubs meet to learn a new building and programming concept. At these meetings they are given additional challenges to complete during the month. These additional challenges are called Hotbot challenges. Below is an example of monthly Hotbot point opportunities (see figure 5).

JANUARY 2012 HOTBOT POINTS

(DUE TO MS. MARIAH BY FEBRUARY 19TH AT 5 PM)

HOTBOT OPPORTUNITIES FOR BEGINNER, INTERMEDIATE, & ADVANCED:

POINTS	ACTIVITY
10 PTS	Safely Surviving the DRY Ice Experiment (everybody has their fingers, eye balls, etc.)
20 PTS	Explain (via video) why the dry ice makes a bubble on top of the bowl AND why dry ice is dangerous to your fingers if handled inappropriately.
20 PTS	Ancient Graffiti (pages 57-59 of Florida Public Archaeology Network, supplemental material received at Robotics Kick-Off, use your Mayan hieroglyphs for inspiration) Also, you can break the youth into different groups and have each group come up with a story the other group has to decode.
20 PTS	Make a club video or booklet (with photos) that introduces everyone in the club to Ms. Mariah, Ms. Jasmine, Ms. Kelly, Mr.Dale, and Mr. Eric so we'll know who you are when you call!
30 PTS	Make a Come-Back-Robot Toy (follow the instructions below) and send photos/video of the robot and explain how it works.

BONUS HOTBOT POINTS (DUE BY MAY):

These points may be accumulated from January through May. They do not have to be done, they are simple BONUS Points.

250 PTS	Host a 4-H Family Fun Night with Robotics
100 PTS	Have a local newspaper or television do a story on your club.

Figure 5. Hotbot point county competitions

For each challenge completed, points are awarded to the county. At the end of the club meetings in May the points are tabulated and the winners announced. Typically, the county is awarded a robotics camp in their county valued at $2000 or scholarship money towards sending youth to robotics camp at MSU. One 4-H agent said of the Hotbot points,

> I think to keep the kids motivated, keep the contests going, is like keeping the contests. I know that we are all supposed to teach the project and the

> contest is supposed to follow, you learn life skills with that. But I totally think that the contest does motivate them and the idea of the Hotbot points posted. Because they really like that, "Oh, look what's posted, we're going to beat so and so," to see who is ahead of who. They like to see that, to see who is ahead of who. We like to say, "Oh we aren't competing, we are learning something." They are competing and they want to win! I think seeing the different counties posted is important because when they weren't posted they would call and ask me if I could find out. This year or last year there was something posted on how points are calculated or Hotbot points so if we could be very, very specific how points were calculated for the individual or…because these parents are kinda cut-throat too, they want to win. Or "We had just as many points as that kid, why did that kid get first place?

From the viewpoint of a State 4-H level administrator, competition is simply a means to end. It provides the spark to engage youth. This particular administrator oversees all of the competitive events at Club Congress and Project Achievement Days and is responsible for organizing the competition and ensuring the rules are adhered to by all participants, volunteers, and agents. Furthermore, he also trains every 4-H agent in the the state on various aspects of the more than 46 competitions held at Club Congress and 37 competitions held at Project Achievement Days. Of the robotics competition he said,

> The competitive side of it brings the excitement. It says to a young person, 'today I'm the best of the best.' It's not that, the same thing happens with shooting sports or with livestock or with land judging. I

> think the competition is the character that drives a young person to excel. They know that for a year, a month or a week I'm the best in my field. I think that is some of the motivation that gets them turned on.

He continued by saying,

> Competition has been around forever. If you go into the formal education arena they have sporting events and what that does is develop excitement. If you have a winning football team the whole student body seems to be motivated by those wins because they feel good about what they are doing. When you have a losing season, listen to the fans. It is the same way in 4-H. If a county, we have friendly county competition; we have friendly friend's competition. In some of our in-service training I do a simple thing it's called Building our 4-H House. Once you get that home built, we have a little chimney on this house. Up there we say "competition." So it's a very small portion of the total experience, but it is an important part because if you don't put a carrot before some of our kids they won't ever try to experience it. So it takes several factors to get young people involved and competition is one of those. It can be fun and it can provide that excitement. I figure if we didn't do project achievement days and club congress, really and truly I think our numbers would drop pretty drastically because we know this county is a very competitive country, our state is and our kids need that opportunity to understand that nobody is going to walk up to them and say, "Here's your life of resources, financial resources. You don't have to work. You have to compete for jobs, you have to compete in schools for grades, it's all around us, so competition is probably a great way to get young people turned on.

> I had one tell me “We didn’t get first this year. We’re going to go back and study till we become number one.” That is a good response that you want to hear because it means they weren’t mad because they lost they just know they have to do better to win next year. That keeps the cycle going. Competition is a good motivator.”

The only other research study (Sklar et al., 2003) that was found in the review of literature concerning robotics and motivation would agree with this administrators’ assessment of the importance of competition as a motivational factor in robotics. Research conducted by Sklar et al. (2003) examined the impact of the RoboCup Junior competition on students from various countries. RoboCub Junior is an international robotics competition that is similar to the FIRST robotics competition described in chapter two. These researchers found that

> RoboCup Junior fits in with existing robotics curriculum; is highly motivating for participants; advances both academic and personal development skills, teaches teamwork and tolerance of others; and appears to attract girls into robotics as well as boys. The RoboCup Junior competition itself is a motivating factor, particularly because it is an international event, it imposes an absolutes deadline (that is, the date of the conference is fixed), and it gives young students and entry-level role in the complex and stimulating field of robotics research in an exciting context – alongside the senior RoboCup competitors, some of the top robotics scientists and engineers in the world. (p. 45)

While the 4-H robotics competition is an extrinsically motivating factor, the reward also plays an important role.

Plaques, Ribbons, and Recognition – Factors in Extrinsic Motivation

Currently, all teams must be ranked after competing, even if the team finished tenth place. All teams are awarded a ribbon: blue, red, or white. Ribbons are awarded based on effort, therefore teams that placed first through fifth could be awarded a blue ribbon, sixth through eighth place could be awarded a red ribbon, and ninth and tenth place teams would be awarded a white ribbon.

Junior 4-H'ers who place first at Project Achievement Days also have their name called out and are brought on stage to receive a plaque. Each member of the first place team is mailed a check for $25 after the event. Senior 4-H team members that place first are also recognized on stage at Club Congress in front of roughly 900 peers from counties all over the state, they also receive a plaque and a check for $25. Interestingly, of all of the rewards offered, youth participants said that recognition in front of peers was the most rewarding, followed by the plaque, the money, and the ribbon.

Recognition seemed to be more important to the senior 4-H'ers and perhaps that is due to the scale at which they are recognized. A 15-year-old youth said, "I would say having my name called out, but everybody always gets [pronounces] it wrong. When they get it right its having my name called on stage." The 4-H Club Congress awards ceremony takes place in the Lee Hall Auditorium at MSU and the youth are called on stage where their image is projected on a big screen for all to see. They have their picture formally taken by a staff photographer in front of the MSU seal. The photos are then sent to their county as well as local newspapers. A senior 4-H'er said of her first place victory at Club Congress,

> Hmm…I think it's more the recognition, the plaque of course is cool, the money is cool, it's really just the fact that you won and you know that you did something, that you worked really hard and it paid off, you know? So, the money, the plaque is of course a plus, you get to hang your plaque on the wall and be like hey – look what I did. But also, just letting people know, uh, about it and stuff, so . . .

Another senior 4-H'er said of his first place victory,

> Well, I really like money and I really like recognition, the plaque probably holds the most memory though, I mean plaque and ribbon are pretty much the same thing you know just different forms. The plaque and ribbon represent what you've done. Congratulations, this is your success, the hours you put into it, the nights you stayed up until 10 o'clock laughing at random names you give your robot you know and building that robot that paid off, this is what you get for it, you get a plaque for it that has your name on it, first place.

The plaque is a physical manifestation of the memory made, the time spent, the recognition received. A mother of several 4-H robotineers said, "I think the name recognition, being called, I think that's a bigger thing but anything that they won, it's all recorded in their record books and its recorded somewhere in their papers, so that's kinda cool but the monetary thing, I think they really enjoy monetary things." She continued by saying that her children win a lot and thus they receive numerous plaques. Of recognition the mother said,

> Plaques just become…plaque, plaque, plaques, plaques. You know what I'm saying? Which is fine, I mean, um, you run out of room for them. I think certificates, that is something that can go in a scrapbook, and they have it the rest of their life when they're flipping through their scrapbook. It's hard for them to…Yeah! I got a plaque! You know what I'm saying? A plaque is not going to be up there for the rest of their life.

Another male volunteer stated that his teams' favorite thing was, "coming on stage in front of everybody with their plaques. They were so excited. They were like, 'Yeah, this is ours!" However, one 4-H agent confessed that while her youth may try to be humble in victory that, "they liked the name plate [plaque], but they liked the money and they liked being called up on stage…"

Competition is part of an overall strategy developed by 4-H to move youth through the learning process in such a way that they internalize what they are learning and are then able to act on it. A State-level 4-H administrator said of the robotics program,

> When you think of life skills that they acquire through their involvement in these projects I think this particular project will be just a step or two ahead of some of the other projects. In the fact that, we all know that in life young people are going to need those math skills, those science skills in order to be productive citizens. The livestock project allows them to do some of that but I think that the Robotics project probably does that the

> most because of the nature of their involvement in programming. The math skills that they learn, all of those things, the science skills that are there; I think that those things are going to give just a little bit of an advantage, not to say that the others don't do that. I was just thinking about the whole district project, in the Robotics project every step along the way you are going to get those skills that we talk about.

As part of the competition 4-H'ers are required to do a presentation on their strategy, programming, and building of the robot. In addition, they are required to answer questions from judges based on their work. The presentation and the question session serve as a checks and balance on the robotics program. It allows the youth to internalize what they have learned and verifies that the youth are actually doing the work instead of their parents or volunteers. However, the 4-H youth do need help to prepare for and compete in the robotics competition. Ideally, this help comes in the form of fellow teammates.

Teamwork and Finding a Place to Belong as Extrinsic Motivational Factors

Another influential motivational factor for youth is teamwork. It provides an extrinsic motivation for the 4-H'er. An 18-year-old male participant said of the importance of teamwork,

> What I like the most about participating in robotics is the teamwork that it involves, the interaction from others, because you can't, it's hard to do it on your own. And when you get together with people it becomes more fun, more enjoyable, the success is usually greater.

A 15-year-old female noted that her greatest motivation, "It would have to be teamwork. I know I'm saying that a lot. Knowing, like I wouldn't want to let them down, they're doing all their stuff and me not doing my part. I guess that's what motivates me." An 11- year-old male participant stated believed that teamwork made the job more manageable. He said, "I find it easier 'cause if I'm adding little attachment to help it work better they can be programming it." The only other research that examined motivational factors also concluded that teamwork was an important driving factor in the success of the team. While observing the RoboCup Junior competition, Sklar et al. (2003) stated,

> The emphasis on teamwork in RoboCup Junior allows students with a variety of interests and abilities an opportunity to pick their own challenges while they contribute to the progress of the whole, and experience that nurtures the varied and multiple intelligences of each participant. (p. 46)

Participants in this study also noted that teamwork was an important factor in the success of the team. Thus, teamwork has dual motivational roles. The role of teamwork as a factor in success is discussed further under research question five.

Ability to Reach Future Goals as an Extrinsic Motivational Factor

The youth who were interviewed for this study indicated that they were motivated to participate in robotics because it would help them in their future endeavors. According to an 11 year old male participant, he participated in robotics, "Because I want to become a scientist and I think learning about robotics would help me." Another junior 4-H'er said, "I want to be kinda like a scientist inventor, I would like to work with chemicals and motors and stuff like that." One junior 4-H'er said that he wanted to, "maybe be a farmer, an agriculture engineer, something with agriculture" because he liked the big tractors. The children were able to see a connection between the skills they are learning in the present through robotics and who they hoped to become. Younger children, or junior 4-H'ers, generally tended to believe that robotics would help them become a certain type of person, such as scientist, engineer, etc. whereas older youth felt that robotics would help them as they entered college and decided on a career path.

Senior 4-H'ers were able to define more clearly their hopes for the future. The closer the youth get to graduating high school the more specific the ideas became. A 14-year-old male said that he participated in robotics because, "It's a lot of fun and I'm hoping it will look good on college resumes and stuff like that and just to learn more about robotics. It's a good learning experience." He further clarified the type of engineer he wanted to be, "Probably, maybe a mechanical engineer; I don't know, but probably something like a mechanical engineer 'cause I know that if you're a mechanical engineer, you can get into the robotics field." It is at this age that the shift in their thinking becomes more apparent, it goes from a vague recognition of distant possibilities, to a more specific step by step process of reaching those goals. Furthermore, senior 4-H'ers see robotics as a gateway to their future. One senior 4-H'er said that he wanted to be an architect, and that, "people who go onto architecture, like me, uh, need, to work with others and that's what they're teaching us here, and building and programming." He wanted to become an architect so that he could, "First, make quite a bit of money" and buy a good house close to home. Another senior 4-H male said that robotics was a bridge to his future, I guess it's really going back to that dream, it's the reason why I want to go to mechanical engineering. The more I do now, the more I succeed now, the better chance I have to reach that dream in the end. I have a dream of what I want to be, where I want my job to get me, I don't have a dream job. I'd like [it] to get me to a house with a good woman and a family. That's where I'd like for it to take me.

Younger 4-H'ers view their future as something external to them whereas older 4-H'ers see themselves in the reflective glass when they think in terms of becoming an engineer or a scientist.

A 16-year-old male youth said, "I hope to put it on my resume (for college) since I have a couple of years under my belt I'll probably get pretty good at robotics, so…I'm really hoping that might help me out somewhat." Another 18-year-old senior female 4-H'er said of her time in the robotics program,

If I went into engineering I would definitely use it a lot but I'm probably not going to. But I think just, the skills that you use to figure out what you need the robot to do, I think just the basics of it and even science, because in college you have to use science, and all the science experiments that we did, all the really hands-on stuff, and even just the communication skills you go to all the competitions you meet all these people so I think so I think that does, science, engineering, and technology will definitely come in hand in more ways than just using it in engineering so . . .

This particular 4-H'er recognized that while she was not planning to go into engineering her participation in the project provided the supplemental benefits to her. These skills would equip her with the tools to pursue her goal of becoming a nutritionist. A senior male youth said of his participation in the robotics program, “It has helped me out with my career options. I’m deciding of going into mechanical engineering at Mississippi State and it has helped me with that. It’s given me a feel to how to work with robotics and a bases for engineering and physics and such.”

While the senior 4-H’ers set their sights on future careers and college, the adult participants see robotics as a positive step and a necessary life tool. From the adult perspective a key motivator was the hope of what robotics could do for their youth. A female 4-H agent said of robotics,

> I like it because it is oriented toward youth that you may not typically reach in your normal agriculture related projects; it reaches a different audience with 4-H’ers. It reaches a group that you might be able to reach with your typical cooking or cows or whatever related projects, it reaches a different audience. I like how it is going to prepare them for later on down the road I can see this potentially being their career paths.
>
> I know we use all the products and tools to teach life skills and I think this might be an important life tool to reach them and teach them some other life skills. And also once we get them involved in Robotics I’ve been able to get them involved in other areas of 4-H too.

For the parent, or volunteer, robotics serves as a gateway to a better life. A mother of two youth that participate in robotics said of her sons’ participation,

> Because one of my sons is going into engineering. You know and like, my youngest son, ya’ll just don’t know what it has done for him. That 13

> year old, competing, his reading, wanting to do more with that, it has helped him and that's what I like about robotics. Every year he looks forward to robotics. Beside games and sports, ever since he won robotics, he's been into robotics, that's all he want to do. I want a big one, I want to do right, I want to do this, I want to advance, I want to win first place in everything this year in robotics, you know, so I have seen a change in him, you know and I love it. I love it. [It] Make him think, it challenges them, it challenge his mind. So, just to hear them talk, and him being enthusiastic about it the way he is, about robotics and then going with his friends and they're competing, man…that's awesome to me. Because you know, at one time, he wasn't enthused about nothing so when he make a 360 like that and he find something that he enjoys doing and it's educational and it helps him in the long run then you know I'm all for it. You know I wish they had robotics something every month, you know for them to do. Because it's helping him in school, reading, you know, coming up with new things. Now he's talking about inventing his own robot. I'm like, ok! You know, and I like that.

The mastery youth attain by participating in robotics gives the youth a sense of ownership which they then internalize. This leads to greater self-confidence and this confidence propels the youth into trying new things. A mother of a junior 4-H'er said of her son's participation in robotics that

> It gives him courage. To me this is something that he looks at like oh, wow – something that's really cool but also something above him and as

> he progresses in it, it's like an accomplishment. Whereas he could learn his spelling, he could learn his cursive, you know, he could even learn his science but there's so many different aspects of science, you could be good at one thing or not good at something else, or even math – he's excellent at math. For robotics it's like stages, as he accomplishes he's building more and more courage, I think. That's why it's good for him; it builds him up for and more things to try.

Courage is something that most youth do not come into robotics possessing; rather it is something they develop over the span of their time in robotics. It give youth the courage to explore who they can be rather than what their immediate society expects are what they are told they can be. Another mother of three "robotineers", ages 18, 15, and 10; said that

> One thing with robotics, I think the more my kids get involved in it, I think it will help them choose what career path they want more. Had they not been involved in robotics, they wouldn't even have a taste of it so they would just be like Nicky…she kinda went back and forth with it for a little bit. But she's going into nursing but for a while she thought maybe she wanted to be an engineer when she was dealing with robotics but I think her heart is still into taking care of people, and that's something robots can never do, you have to have that hear and feeling and robots don't. But…like I said, that helped her make her decision so robotics is important…It just builds their confidence that one step higher. But once

> again robotics – it is the future. It is, for succeeding in robotics means you are succeeding in the future.

Most parents come to robotics with the hope that their child will find a place to belong and grow. After observing a robotics workshop one state level administrator commented,

> Parents want to get their kids involved in things that will help them be more productive citizens and be the best in their field. I see the robotics project doing a lot of that. I think those are the variables that create the excitement.

There are numerous intrinsic and extrinsic factors that contribute to participation in the robotics project. Intrinsic motivators included an internal impetus within the youth and the belief that robotics is, in and of itself, fun. Extrinsic motivators included seeing the robot built; participating in contest, working together, finding a place to belong, and the view that robotics is a bridge to the future success of the youth. While the youth in this study identified the realizations of their future expectations as a key motivating factor, they also shared a common belief that robotics was an important key to their future.

Research Question 2

Motivational Factors that Influence Volunteers

What motivates volunteers to help 4-H youth participate in robotics projects? Volunteers identified three motivational factors that influenced them to support 4-H youth in robotics; involving youth in positive activities, creating opportunities for their youth, and lastly, encouraging youth to persist in the face of difficulty. A mother of three children who leads a robotics club said of robotics,

> I guess the most exciting part is that it is such a big thing and like for my son Eric, that's, he's a geek in all aspects, and to have something that he fits in so well with 4-H has really been exciting and then to watch my other two who aren't really geeks but still fall in love with robotics and have it be something really fun, exciting and challenging all at the same time, you know?

Volunteers contribute countless hours to the robotics project and often act as the primary instructor for the local county club. The amount of time, effort, and energy they put into the robotics program is directly proportional to the excitement level and enthusiasm of their youth.

Motivated to Involve Youth in Positive Activities

Volunteers seek activities that engage the youth in positive extracurricular activities. According to a senior level state administrator,

> The thing that really turns me on is not so much my involvement as the expression, the excitement on the faces of the kids. Last year you had a robotics camp I happened to stop by when you had all the things right here in your office. And to hear the parents talk about it and to hear the kids talk about it, it is the utopia of what you want 4-H projects to do is to be a wholesome family involvement. If you can get the kids turned on, which sometimes is not that hard to do, but to get a parent to come, stay with them, hands on themselves. Then when they go home they are going to continue to do it. I've always said that in 4-H if you can get the parents to support what the kid did they will be successful. I think that is the part

> that turns me on the most, to know that it is a project that allows the entire family to take part. It's been a long time since we've had a project that did that.

Once parents and volunteers find that activity, they are willing to commit a large amount of time effort and energy to seeing it come to fruition. A father of three youth involved in robotics (ages 18, 14, and 10) said of his children's participation,

> I think it's just the activities. Keeping the kids involved. A buddy of mine, two of his kids, I said, dude, what kept your kids off the street? Why did they take the good path and not the bad path? He said, "I'm going to give you a hint. It's keeping them involved with stuff, keeping them…if you don't have something for them to do they're going to find something to do." So, I'm like if they even want to do it, we're going to go do it. And that's been wonderful; 4-H has many outlets for almost anything you'd even dream about doing. And robotics is a wonderful aspect of that.

The state level administrator said that, "Parents want to get their kids involved in things that will help them be more productive citizens and be the best in their field. I see the robotics project doing a lot of that. I think those are the variables that create the excitement." The robotics program offers an alternative activity for youth who enjoy hands-on activities. This is particularly applicable for those youth with limited access or exposure to high-impact activities such as robotics. Robotics provides a safe place to build knowledge and skill levels with other like minded youth. According to one female volunteer felt that there was an important difference between her sons' after-school basketball activities and his participation in robotics,

> At school they're more laid back, in robotics they have to know what they're doing. If they don't then they're going to come in last place. At school, say for example, with Daniel his teammates, like with basketball is totally different from robotics team. Because they're more concerned about basketball, even though both are concerned about winning, but the atmosphere and the conversations are different, totally different. Where they may talk about basketball on Facebook some but when it go to a competition they have a certain group of people they going to talk about robotics and but the other part, they going to talk to the other children about basketball so it's a difference in how they communicate. Like Daniel, talked to his coach, normally they wouldn't let them miss a practice, or something like that but when I told him that Daniel was in robotics and he had competition at Mississippi State, "Oh, let him go, please you come back and you represent us." When teachers or other grownups that are concerned about children and when they see that child that is trying and they are trying to better themselves then they're more apt to let them go and do things, so…they're well rounded.The atmosphere with the children is different. When it comes to robotics and sports, and shooting, I don't care what sport it is. When its robotics most, one little boy called Daniel, he said, "Oh, Lord, you gonna be one of those geeks." He said geeks is gonna get me in college. They're smart children, but like

> I said, it's a challenge and they just love that, you push them, and encourage them that they can do it and when they're coming up, putting in their mind that I'm going to invent something and next year I'm going to do better or I'm going to try something different."

In the case of one father, whose children are homeschooled, the robotics project provides supplemental learning opportunities to what is provided by the homeschooling curriculum and the robots can be checked out from the local 4-H agent, saving the family money. In addition, the local 4-H agent helps to purchase supplies and materials for the club and the 4-H agent also helps to introduce new children into the club. According to one homeschool mother, she volunteers with robotics because,

> I guess to just give my kids another experience in something, especially like Caleb, say OK, you're really interested in engineering this is part of what you would be doing and letting them be exposed to that aspect of robotics. And being homeschooled we wouldn't have had that opportunity without 4-H to show them robotics and what it is about so . . .

The opportunities to experience new things and work with new people help to broaden and define future. In the latter case, the mother of two helped her children navigate a cultural norm such as being on the basketball team, and what is outside the cultural norm, being on a winning robotics team. In these instances both volunteers share a common goal, to involve their youth in positive activities that encourage youth towards a better future.

The youth viewed fathers as more helpful with building the robot whereas mothers were seen as encouragers and problem-solvers. A senior 4-H'er said that his mother motivated him to be successful in robotics. Of his mother he said, “She helps me a lot. Like, if I don’t know how this piece is supposed to attach she comes and flips the piece and stuff like that, things I wouldn’t really think of.” Another senior 4-H’er said that his dad helped, “because my first year in robotics he helped a lot and was really interested in it and he came over a lot and helped with the programming and helping me understand that first year.” The time spent on robotics was considered time well spent since it engaged youth in a positive activity and helped create a positive future for their children.

Motivated to Create a Future for Youth

Helping the 4-H’er to prepare for a better future proved to be a key motivator for volunteers. Participating in robotics was a predictor of future success. A father said of his junior 4-H’er, “It [robotics] makes him think…opens his mind up, plus the future, I think the future is going to be a lot of robots. And it’s going to open up job opportunities and maybe he’ll wanna pursue this as a career because there’s a lot of careers out in robots.” Each of the volunteers saw robotics as playing an ever expanding role in society. A mother said that she liked

> the part about robotics because it’s technology. And that is what our future is gonna be. Technology, it’s all about technology and computers. And so as far as getting them mainstream into that society, that technology . . . I think robotics is great as far as introducing them to that.

A male volunteer reflected,

> I think that as we move along in our – I won’t say evolution – but our progressive state, robotics is just going to be taking over more and more

> and that things that we might repetitive task, that might have a role for robotics, and that we might see that more and more, and as we see – I won't say a role, but that is a logical path that I can see.

This father believes that if his children are to be successful in life they will have to be able to deal with technology and more specifically robots. Many of the parents and volunteers that work with the robotics project think that by their children participating in robotics they are open to new experiences and new ways of thinking that in turn will help open them up to other ideas and life pursuits.

A mother spoke of her hopes for her children,

> That they'll go on to college, become great inventors, take care of their mom (laughter), take care of their mom and you know this, just become a better person. You know, and that they're good children. You know even the ones that have gone on, they're excelling. And when they grow up, especially young ones when they grow up and go to college Daniel talk about being an engineer, David talking about being a scientist, architect something, and I know that this is going to help them out down the road, you know, even though its robotics, its thinking, its teaching them to think outside the box, and I like that.

An male volunteer, who also happens to own his own business and serves on the city council, said of the youth participating in his county,

> I don't just want to see every kid who participates in this program to have a successful life in the work field, but owning their own businesses, becoming their own boss, becoming their own supervisors and training

other people to do the same. I could see that happening with some of these kids.

Being competitive in a future job market was important to another volunteer, who grew up in an Old Order Mennonite culture with no television and whose education was finished after he completed the eighth grade. As a farmer he felt that robotics was

> important as for the future, you're going to have less and less manual labor and more and more robotics and to be able to understand it and either operate it or fix and maintain, that's the only way to stay competitive in any field whether its agriculture or industrial.

He continued by talking about the other 4-H projects and their relationship to robotics. Of them he said," I like the other things, like dairy, I was raised on a dairy farm, but I guess I felt like that you can learn dairy anytime but the robotics if you know how to use mechanical things that would be good in so many things, it would be applyable as a broad field to be in and it seemed like a good thing to learn." Further, he felt that, "It seems like it [robotics] would be good future and it's good to see something people have a future in."

In order to create this future for their youth, the volunteers have to work hard to provide encouragement to the 4-H'ers. One mother said of her role as encourager,

> I think the only thing that might be stressful in working with the kids is sometimes they are too hard on themselves. And so you are spending more time of saying, cause I know this is with me and my children, you do your best and the heck with the rest. You do what you came here to do and if it falls apart, you know what? You came, and you did what you

> were trying to do, it didn't work out but you accomplished it, you finished it, that's it. And that's what I teach them, do your best, heck with the rest and that's always what they've done. And they, I'm not going to tell them they can't feel sad if they didn't accomplish it but they just done it, and that's it. Yeah, you done it, let's go. You didn't win but you did it, you learned a lot, let's go. And that's what it's about.

The encouragement that volunteers provide forms the foundation for the extrinsic motivation youth expressed earlier. The volunteers help that child create a foundation for their future. The volunteer is then motivated to encourage that child towards future success.

Motivated to Encourage Youth

A male volunteer who identified his role in the club as,

> I think I'm more of a motivator than anything to push the kids and help them work out small ideas, they do all the work, we just kind of, and maybe something that needs to be tweaked here and there, other than that, I'm just a big motivator, cheerleader.

He went on to say that,

> When they get frustrated on how to make the robot do certain things, I just give them a few ideas, hey man, you're going to get it done. Don't worry about it; we're going to win this thing. You have to speak victory before it's there.

“Speaking victory”, creating a vision, and teaching life skills, are at the heart of the robotics program. Its purpose is not to entertain but rather to give youth the necessary tools to succeed in future endeavors.

Another volunteer repeated this sentiment and explained more fully what it looks like to be an actual hands-on volunteer:

> I put in their mind that you can do anything you want to do, you can be anything you want to be as long as it’s positive. You know don’t go in here thinking that you’re a failure from the jump you don’t do that, you go in thinking that you are a winner. Whether you win first place or third place, you are still a winner because you put forth the effort to go in here and do what a lot of people would not do. Going in front of a lot of people and other schools that are competing for the same thing that you do so don’t ever think that you are not a winner because you are. You never call yourself a loser, you never say you can’t. Can’t is not in the vocabulary. You can do anything, and like with my children some people may not want you to say this but with God all things is possible. So, I tell my children whether I birth them into the world, all these children are my children, you know . . . when we go they are our children and you know I just encourage them, don’t stop. If something don’t work, you find another way, you make it work but you just don’t stop. And so, tell ‘em, that I love each and every one of them, I do, so I just put my arms around ‘em and hug ‘em and you can do whatever you want to do. And I’m going to make sure you do it.

By "speaking victory" into the lives of 4-H youth volunteers encourage youth and create a vision for the child's future. These two motivational factors, creating a future for the 4-H'ers and encouraging 4-H'ers to persist in robotics are two distinct factors that work together to create victory in the life of the child.

Research Question 3

Influence of Gender on Motivational Factors

Are the factors that motivate 4-H boys different than that which motivates 4-H girls? The answer to this question is less clear than the previous two questions. Of the girls interviewed, the majority stated that there was no difference between the boys and the girls, everyone was equal. However, the boys and volunteers were much more clear on not only what motivates girls but their role as well.

Youth Participant's Perception of Gender Influence

One 11-year-old male participant said of "the girls," – "They just kinda read the boys the instructions, [using a falsetto voice to imitate the girls] here build this. Sometimes they would get up and help. That's cool." According to one 15-year-old male participant, "The girls use their mind, not their muscle." Another 18-year-old male participant said of his team,

> At first, at first we were building our robot, Abrutus, they contributed by taking pictures with the different parts while I built the robot [laughter] but this past year especially they stepped in and did a majority of the work they did a lot of the stuff, so . . . they stepped up this past year."

This same youth continued by saying,

> The first year, in the beginning I did most of the building. I pretty much built Abrutus. I don't mean to take credit but it was pretty much, yeah . . . but this past year, they pretty much did everything, pretty much equal, you know you could tell. They maybe even did more.

The girls were seen by the boys as being in a more supportive role and their job was to 'decorate the robot and do the videos.' A 16-year-old female said the boys paid attention because they were afraid of what the girls might do to the robot,

> They [the boys] listen, they pay really good attention because the boys are like, if the girls are like, let's build a frog and dress it up, no lets' build like a scorpion. Let's make sure it's manly.

The younger boys were not overly concerned with girls at all, but they did say that girls who took charge in the robotics club were "bossy," however none wanted to be quoted officially on that matter. The older youth, especially, the boys were very careful when describing the role of girls in the club. They would talk about specific gender roles in the group and then automatically follow up with a statement along the lines of, "Works out just as if they were guys. You know it's really, it's, it's not really a difference of girl, girl – it really doesn't make a difference."

The youth also used their state-level robot leaders to differentiate between the roles of boys and girls. Many youth commented that girls could do robotics because the state level instructor is a female and if she can do it then other girls can as well. One male youth said girls could do robotics because, "You're [Mariah] pretty good at it." However, a senior female youth said,

> I would say that you're good at robotics but, because like, you know so much you can teach others, I think that's whenever you know that you are good, you have it so down that you can show others what do to, so I think that's something else to . . .

But for the adult volunteers, gender does make a difference. Volunteers were likely to describe the female robotics leader as fun, laughing, and smiling. Conversely, the male robotics leader they described as, "He had a way of talking to people that the kids would pay attention to, when he talked, everybody listened."

Adult Participant's Perception of Gender Influence

According to a mother of two boys,

> The girls do more, well…decorating I know…programming they all do it you know, the girls are a lot more, well…creative but you have some guys that are creative too. But the girls are more creative and decorative and adding sound and all that kind of stuff. Just so, everything have to be…I'm like that. But guys you know, guys they more into the building, the electronic part of it, the Bluetooth, making sure everything works. So, it's a difference but when they all come together, you know, it works.

One proud father (who has one senior daughter and two junior boys) said of the boys versus girls debate,

> The girls have a more open, honest approach of how to do things and some of the guys just want to get in there and do it. I think as time goes on there's going to be more girls involved in it. I think they have more of a logical approach to things, instead of trying to get that square hole with a

> round peg, and it's like nooo, let's think about it before we actually go out and do it. I think that helps out and as a team, as a whole that there is a logical path that you can follow, sometimes ladies have a more let's think about it before we go out and do it. As a general, I think all of them should have a girl on the team. Think about it before we do it, you know? Maybe this is ok that we push it once before we picked it up and moved it back, we don't have to change the whole program just because it knocked it you know? I think it's a good thing.

Another father of three girls said,

> I think the girls are more analytical, I remember Olivia, how she wanted to analyze things to a T before she actually put it together. Now the guys see a program, they put it out there and see if it's going to work, and then they'll come back and to tweak it out.

A female volunteer said of her girls' participation,

> Oh yeah, now it's funny because get this – like the first year that they did robotics it was Lesley, Emma, and Greg on a team because Katie didn't want to do it and everybody else was younger. And Greg did most of it, and the girls just sat there and played with the robots, they put tires on their eyes and took pictures of it and wrote I love you with the little tires and took pictures of it while Greg was on the floor trying to get it to work. That was the first few practices, and they started getting involved, and then the next year Emma wasn't doing it but Lesley was still involved. Lesley started getting more vocal, to where she was like no, we're going

to do it this way. And she would be programming the robot and then this last time she would be upset if Greg had said this is my way, she was like you haven't tried it my way. So, she…I could see the development of her being more confident about what she was doing and now like no, that's not the only way to do it. You haven't tried mine so lets' try it before…So, it's just funny to watch that because literally the first one, I have pictures of them with tires on their eyes. And they are writing I love you and there's Greg sitting on the floor programming the robot while they're playing with the thing. This last one, she's at the computer, Dale's trying to program it, and they're programming together, figuring out how to aim it so it was really fun to see it to change and come across.

The volunteer continued by saying that during the first few years the boys viewed the girls as "eye-candy" but over time that changed (see figure 6). Initially, most of the female participants were "drafted" into the robotics club so that they could have enough participants on a team.

Figure 6. Girls as eye-candy

The girls gradually took over doing the interviews and videos, but because they did more of the talking with the judges at competition, they had to learn more about how the robot worked. Once the girls figured out that they could do robotics too, they took a more prominent role in the team.

A 4-H agent said of her girls,

> They pretty much tell the guys what they need to do! It's kinda like Olivia, the group leader. She's finding her role, she set the practices up and said they were going to practice on this day and this is your role, this is what you need to do. She kinda coordinates the whole group.

This agent continued by saying,

> It's nothing like, 'Oh, we don't like girls.' I mean we are all friends, they are all friends. I just saw the girls taking a more taking charge directing the boys and planning things out. But like the boys took more over the computer programming and stuff and then for the Robot Roundup the girls made the set.

From "eye-candy" to group leader, motivational factors that influence female youth are different than those factors that influence males.

Research Question 4

What role if any does race play in the motivational attributes of 4-H'ers, volunteers, agents, and stakeholders? When the participants were asked this question they all responded with an unequivocal 'no' or just complete bafflement that the question was asked to begin with. However, the one overwhelming response to this question was, "no – but that really aggressive team from Alexander county had the absolute worst sportsmanship of any county in the entire State." A 4-H agent said when asked the question,

> No. The only thing they commented on at the Juniors was that the Alexander County people needed to calm down, that was the only thing. And then my volunteer came out and said they [Alexander County] cheated or something like that. Since it wasn't specifically written in the rules they get away with something. That was all. Nothing specifically about the black groups or the white groups. I haven't heard any comments about ethnicity or cultural differences or anything.

It is possible that the participants equated a question about ethnicity as a potential negative and the more pressing negative was in their mind, the very-unsportsmanlike county that had everyone talking during the 2011 competition. According to a female volunteer that had a first-person account of what happened with this particular team she said,

> I did find though that even those teams that were kinda crazy some of them were still willing to help so it wasn't just like they were *so* crazy that they wouldn't tell you or talk to you or if you had help but, just a lot more intense. Which I think made the kids more intense. And I saw kids at project achievement days almost in tears and I thought, this is not what this is supposed to be about, they shouldn't be in tears.

Another female volunteer who chose to keep her youth far away from this particular team said,

> I'm saying these children are just competing; I'm going over here to stand. Somebody might start swinging. These are just children you know. They too young for that, you go to a point where you just have to stress those kids out like that, I didn't like that, I didn't like that. But I wasn't going to say anything about that because that's their children as long as you don't come over there hollerin at mine, we ok. You know, let them have fun that's what it's about, having fun. Even though you get in competition and it is stressful, it is, but it should be fun.

A mother and volunteer of a junior robotics team compared her children's efforts at competition to a battle between David and Goliath. Of it, she said,

> This year it was an extra pleasure to win because there were so many teams that were just so unsportsmanlike, to watch my team, just this little meek team you know, little quiet boys, to watch them win was just an internal – wow! Because it really seemed like there were competing against Goliath but uh, no…I think all the teams, really, I think at the heart the kids really just want to have fun and succeed.

In an effort to curtail the unsportsmanlike behavior and relieve the pressure of the youth, a Robotics Fun-O-Meter was introduced for the youth to use (see figure 8).

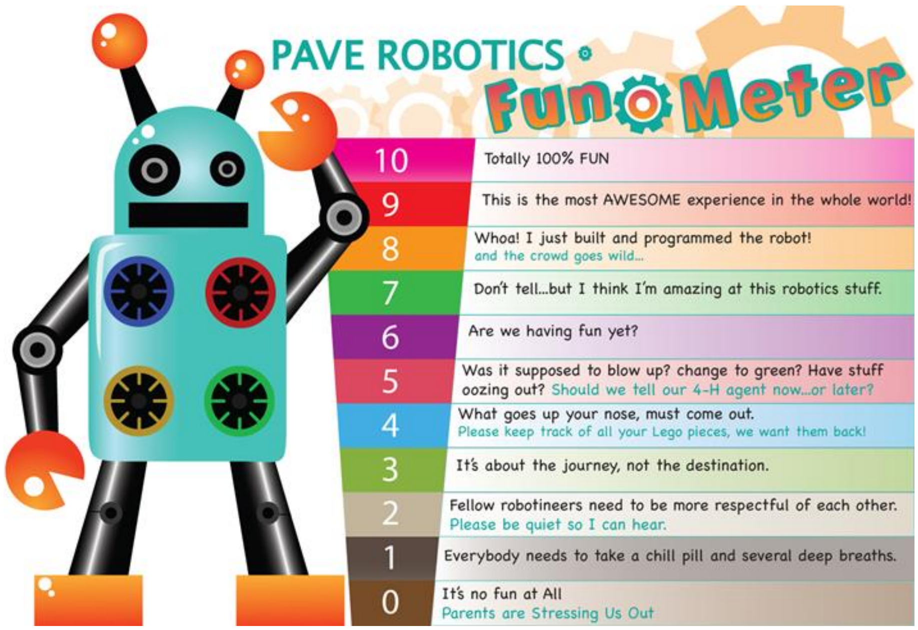


Figure 7. PAVE robotics Fun-O-Meter.

While children may not directly be able to tell their parents that they are embarrassing them or stressing them to the point of tears, they can move the cog up and down the fun-o-Meter during contest or club work to let the parents know that children are not happy with their behavior.

Research Question 5

Factors of Success Identified as a Motivational Factor

What is the role of varying factors of motivation in success? What does "success" in the robotics project mean for the youth, agents, volunteers, and stakeholders? Participants that were interviewed for this study identified four factors of motivation that determined success and while most would say that "success" in robotics meant "learning something new," success was measured by victories won and opponents vanquished. Other factors that contributed to the motivational factors that led participants to success include, teamwork, ability to resolve conflict, envisioning the end result, and dreaming a dream.

Winning as a Measure of Success

The junior 4-H'ers feelings about success can be summed up in the words of one 10-year-old boy, success means, "To do your best and place first." Older 4-H youth were able to expand on that factors that motivated them to succeed and not surprisingly their statements were comprised of both intrinsic and extrinsic motivational factors. For example, a 16-year-old Caucasian male stated that, "To be successful means to do your best, getting everything exactly right and on time. Working with others, getting along, winning." An 18-year-old female said, "I think the more you learn then the more you succeed. It doesn't matter if you win or get the recognition or do competitions, it just matters what you take from those experiences and what you learn and everything and how you apply that to the future." However, if the question was followed by, is there an example of a time when you felt you succeeded, the answer was much more specific and geared towards winning. This same youth went onto say,

> I guess the time we won the robotics camp the first year? That was kinda cool, all of the fun we had doing the experiments and videotaping them. WE [emphasis on we] had a blast. I think the Hotbot points are one of my favorite parts because they were so much fun but, uh, whenever we won the camp it was the feeling of accomplishment – you know, like wow, we succeeded and this is our first time doing this and getting to go on the site and see where we were as far as points and other counties – oh yeah, we're beating this county, we only have this county to go. You know? It was

> just like this goal so when we won we were like wow, this is so cool. And then you guys came and it was just so much fun so I think that was one of the biggest things that feeling of succeeding. Also, when we won the competition – I know that's a lot of winning stuff but, just anytime that we've really done...just programming the robot and getting it to do one little task make us feel so accomplished. Until we saw the rest of the mat and realized there were five other tasks we had to do. Working like an hour on one thing you would think that we became president or something like that, we were just so excited but, just little things like that to the big where we won the Hotbot and the competition to as little as getting the robot to do one little thing. It's all been succeeding.

A female volunteer said of the success of her junior robotics team,

> Well, last year our junior team didn't place, two other teams beat us. I was fine with that, this year it was an extra pleasure to win because there were so many teams that were just so unsportsmanlike to watch my team, just this little meek team you know, little quiet boys, to watch them win was just an internal – wow! Because it really seemed like they were competing against Goliath but uh, no, I think all the teams, really, I think at the heart the kids really just want to have fun and succeed.

Success for the volunteers is about winning but it's also in teaching the youth to persevere and if winning is a result of that perseverance, it's an added bonus. A male volunteer stated that,

> I think that to have success in something has its own reward. Hey, we did it. We got it to do what we wanted it to do and there's a pat yourself on the back to it you know? And it gives you a motivation for next time and we're gonna do it and do it again. We tried last time, that's what I like about robotics it's not like you have to be the biggest bulkiest kid to hit the ball out of the park, with robotics you can be the skinniest, nerdiest – hey I made it work because I made several more revolutions than the other guy and it did what we needed it to do. You're limited by how far you can dream and if you think about it you can do it and find a solution to the task you have given them. Not like ya'll say, you can't do this, you can't do that, it's like you come up with an idea that you can do it with and as long as it does all the different task, you've succeeded.

Another female volunteer repeated the sentiment,

> If they succeed, which they always will, regardless like I said if they come first, second, third, fourth, they still succeed. Because they're going, they're doing something that's hard. You know, programming is not easy. So, if they succeed at this, you know what? I might stand on top of the building and dance. For them to succeed that gives them the motivation and the desire to succeed at anything else they put their mind to. Robotics, robotics, is an awesome program. It's awesome. Since I've been involved with the program and seeing the challenges these kids have come up against, and just succeeding as far as they have, it's going to motivate them to succeed in anything else that they do. When they go to college, or

> just in life, children, family, sports, whatever, you know, if they can do this, if they can do robotics, Lord knows if they can do robotics and succeed at it, they can be anything they want to be, they can do anything they want to do. They will be anything they want to be and they will do anything they want to do. So, do not ever stop this program. Ever. Even when these children go on, they're going to be others that follow along. And they're saying if these children succeeded, I can succeed to at this.

While perseverance is a means to immediate success it is a factor in long-term success. In order to achieve this success participants stressed the importance of working together in a team environment.

Teamwork as Motivational Variable to Success

Teamwork was a key extrinsic factor in what motivated youth but it was also reflected in the participants' perception of success. Petre and Price (2004) found in their research that the social context was an important driver in motivating youth to participate in robotics. Their study focused on children who participated in the International RoboCup Junior Competition held in England. They found that,

> Many of the secondary school students working in teams learned that programming and engineering knowledge has a social context. They addressed the social context of their own team, reflecting on the nature of decision making with the teams, and on the distribution of roles and responsibilities – and on the consequences of that distribution of roles. (Petre & Price, 2004, p. 154)

A first year male robotics youth said one of the most important aspects of robotics was,

> Well, teamwork. Because if you just work by yourself you're not going to get a lot done but if you have other people working on other things like working on the other half of the robot then it's going to go faster because all you have to do is put the pieces together and you have the robot.

Another 16-year-old female talked about the benefits of teamwork and how working together meant sharing the burden,

> I mean, I guess, because you're always going to be with them, you're not alone, you won't get lonely talking to yourself [laughter] and I guess, I wouldn't have to have all of it on my shoulders, they're there to help me.

She also commented on the need to be a positive team player, "if they're on a team they have to have good team spirit because I mean, I wouldn't want to work with someone that's always like this is what I'm doing…get away."

The younger 4-H'ers commented on getting to make new friends, but the older 4-H'ers were discussed how teamwork was a factor in motivating them. An 18-year-old 4-H'er talked of the discouragement she felt when the robot would not cooperate but she continued her thought by saying, "your teammates are also really encouraging too. At times I would get stressed out and somebody would be like ok, let's just take a break and do something else so your teammates are kinda there to get through it and figure things out and stuff." She continued by talking about how her team worked together to reach a goal, regardless of the robot:

> that robot makes me pretty mad at times. But, uh at times our team would kind of clash and uh, we would have different things in mind, but…this past year our team worked really, really well together so I was kind of

> how good it came along and uh...so I think programming the robot was kinda the biggest thing just trying to get it to do what we wanted it to do but at times we'd both have different ideas of what we wanted it to do so at times we'd be like ok, you try your idea and I'll try mine and see how it works out. You show me what you got and I'll show you what I have so…there was a lot of that but, so…we worked really well together.

A senior 4-H'er who graduates from high school this year and is planning on pursuing mechanical engineering when he attends college laid out a very detailed, concise view of teamwork:

> You have to be willing to put out that effort and not just put it out, but you have to want to do it. That's the mental side of it to start with and then you have to get a team together and you just can't pick random people, you have really have to get people that you have similar opinion on, unless your good with diversity and that's a good thing, you may even get a better result, with a diverse opinion. And, you got to put your team together and you have to decide what you want to do, what you want the robot to do, in our instance we want it to run a course and run certain obstacles and that's how we designed our robot. And you got to get through the diversity of that working with confrontations and such but when you get the design of the robot it's really straightforward, your team works together, you build it, you program it and you go to competition. But to keep that mental side very strong and positive attitude and you want

> to have to do this. Not just of you but the whole team, if someone starts getting out of it you have to cheer 'em up, you know and keep 'em going.

Resolving Conflict as Motivational Variable to Success

When working in a group setting, conflicting opinions on how to resolve building and programming issues sometimes arise. The ability to work through these issues is key to perseverance and ultimately success. An 18-year-old male youth said that there was some conflict,

> Especially when designing the robot. Because everybody has their different opinions, well this would work better than that, that would work better than this. That's another reason I wasn't on the team last year. Me and the team captain had a lot of pointing or conflicting opinions. So, it was better to supervise and just add little opinions here and there rather than trying to lead the team to. I let her do that . . .

He continued by saying,

> But, we work it out and we really test and figure out the best idea in reality. And if it comes to a close opinion I guess we just pick on one. Pick one and decide on because we have so little time to do this and so much time that it requires we're just like OK, we've wasted enough time on this, it's done.

Conflict can also arise between parents and between volunteers and parents but one factor that helps to resolve the conflict and move past it is envisioning the end result.

Envisioning the End Result as Motivational Variable to Success

Being able to envision the robot in a working state is a key factor that motivates youth to persist. All of the participants mentioned the feeling of accomplishment when the robot did what it was supposed to do. They recalled the hours and hours of tweaking, manipulating and complete overhauls that had to be done to the robot to get it just right. A 10-year-old male participant said of the robotic experience,

> Well, first you got to build it, and then you got to program it, first and then the third thing is you have to do see what it does and see if you programmed it right, but if it doesn't do it you have to fix it, like what it's supposed to do, the rotations, and stuff. That was the cool part.

Envisioning how the robot will work and what steps are required to make it work is just the beginning. Those that participate in robotics also envision how robotics will factor into their future successes and dreams.

Dreaming a Dream as Motivational Variable to Success

The younger 4-H'ers participate in robotics because it is "fun." Older 4-H'ers envision where it will take them. A senior 4-H'er said he was dreaming of, "Being an architect, buying a house." Another male 4-H'er said of his dreams, "I have a dream of what I want to be, where I want my job to get me, I don't have a dream job. I'd like to get me to a house with a good woman and a family. That's where I'd like for it to take me." He continued by saying that, "I guess it's really going back to that dream, it's the reason why I want to go to mechanical engineering. The more I do now, the more I succeed now, the better chance I have to reach that dream in the end." All of these dreams require encouragement to come to fruition.

Encouragement as Motivational Variable to Success

Encouragement takes many forms but participants felt that the best type of encouragement was laughter and having a light-hearted approach towards working with the youth on the robotics projects. A senior robotics youth said that the best encouragement for him was, “Flattery, flattery, flattery [laughter]. Flattery, no it’s good but it’s really back to the laughter. Lighten the mood, not to be as intense. When it’s tense, they’re tense, you’re tense because they’re tense, then the whole situation is tense. But a lightened mood is a real encouragement.” A younger 4-H’er felt that having helpers that were encouraging moved him forward. Of his helpers he said, “I guess the helpers that help you like, c’mon you can do this! I was like OK.” Some of the very best volunteers are not those that have the best education or the most experience with robotics but rather those that encourage the youth to reach their goals. A 4-H agent said that she felt that the,

> One on one contact, helping them, that’s how I’m helping them succeed, like a cheerleader one on one contact you know. Just being there for them, make sure they have everything they need. Like before their contest this year, just visit and take their picture and make sure they have everything and what else they need and make sure that they were OK. I think that just being there and talking to them helps support them some.

Having a group of cheerleaders and supporters that support the youth is critical if the youth are to have success in the robotics program.

Research Question 6

Role of Administrators in Robotics and Participant's Perceptions of Administrators

The sixth and final question ask the question what role do administrators have in promoting robotics, and how are those efforts perceived by youth, volunteers, and staff at the county level? Administrators are program leaders and department heads in the Extension Service at MSU. They have budget responsibilities as well as determining where resources such as personnel will be allocated. When the agents, volunteers, and youth were interviewed concerning administrators they were confused as to what role these administrators should play.

One 4-H agent commented on the fact that the robotics program does not send a team to the national competition at Purdue University. Of the competition she said,

> They were kinda disappointed because we had our Hotbot camp in August and they were like, "Why can't we have it till January?" They wanted to keep going. I think they are really motivated so I just think year round would be better. I don't know about funding and stuff, you'll just have to tell me. I just feel like this is something that State 4-H definitely needs to support and if there are some donors out there that would support it maybe for the national contest. Even like $800 to $1,000 I know that wouldn't pay for a whole trip for a team to go, but it would be comparable to what the other teams are sponsored. For a team to go to the National Contest that would be even more motivation for kids to do the contests, yes it would knock them out from competing in next year but you could also use them to train the younger 4-H'ers I think on the county level. And I think

> that having that national contest really says something to you know, when there was that Atlanta contest they were like, "Oh we want to go to Denver!" Or "We want to go to Louisville!" They kinda work towards that. That's kinda a motivation to compete in that contest.

She felt that robotics should be supported because,

> I think robotics is important. It teaches them to work together as a team, think things out, if it doesn't work the first time, think things out and try it again. I think that is a life skill I think we need to keep supporting robotics. I think the state 4-H office needs to support it too and fund it as well.

Funding was a key issue for this agent and it was also echoed by one of administrators interviewed. According to this State-level administrator, he felt that one of his greatest frustrations was that,

> From being involved from a support standpoint, naturally you have to look at the financial part of it that goes along with it. Sometimes the moneys are not there to support the project so that it can reach that next level or give kids a different level of experience. It's just not having the adequate funds to let that project grow and give kids that advanced level of experience that they need. On a national level, in school, internationally because we know that is what we think about, Japan and other countries. Those kids are top notch because those kids have that experience and they have those resources to let their young people to have those experiences.

> That would be the drawback or the thing I dislike most is not having adequate funding to support the project.

However, he did say that "success comes with dollars." Perhaps as the program builds on itself and the results of this research study are implemented there will be more success and with that success more funding.

State-Level Robotics' Instructors Viewed as Administrators

For the youth interviewed, administrators were thought to be their primary robotics instructors that they interact with that are housed at MSU. The agents and volunteers spoke in terms of the 4-H administration as well as the Extensions administration.

The youth placed great importance on their relationship with their instructors at MSU. Of one instructor a male participant said, "Mr. Ricky is like a big brother to me, I actually have him as a brother on Facebook. So, he's really cool. He always lightens the mood up especially when things are tense; he'll come in there with a joke or something. It's really cool. Ms. Mariah is very instructive, and she does a very good job in teaching us at the workshops she hosts and such." Another female participant compared one instructor to qualities she thought every robotics club leader should have,

> Mr. Ricky definitely is really involved and ready to help you out and stuff and very easy to talk to and stuff and so are you are as well but we definitely know that if we ask you a question you'll definitely be ready to answer it and I think that's just one of the things is being very personal, and ready to help because there is a lot of help that goes on in robotics. And, we are always looking for answers. So, definitely somebody who's

> ready to answer questions has to be really enthusiastic – I like that in leaders. That they're really excited about what they are doing because if somebody's really bored then you're not going to be to excited but you guys always keep it really upbeat and be happy so that's cool.

As stated previously, fun was a recurring theme in the interviews, a mother of one junior 4-H'er said,

> I like the way you put all the fun in it because there are so many teachers that are like, engineering is engineering, you know? But you make it fun. You make it to where the kids can understand and they are having fun. They see you and they say she's having fun and she's laughing and smiling.

One volunteer said of robotics, "we have fallen in love with robotics and I think one of the reasons is because of you guys and how fun you've made it and interesting and just, so…we really like our robotics, we really do. She also commented that the instructors have to like what they do if that is going to translate down to the children. Of this transparency she said,

> I think the fact that you guys make it fun and interesting and your open to suggestions from parents like things that work. And I think that you're so excited about it, when they see how excited you are and how much fun it can be, then that, that, relates to them you know? If you're just sitting there and you're just dry and…because they can tell you like what you are doing and I think that comes out across to them.

One mother commented on the role of Mr. Ricky, and the influence he had on her youth,

> of course my kids absolutely love him. They just always talking about Mr. Ricky. He's so funny. From what I know of him, he's just hands on; he's all about the kids. For a man to build a…relationship with, the way he can with children, I think it's great. For the kids to come home and put him so high up, then he's done his job. And it's not all about robotics with him, he is a friend, he is funny, I think he, he does his job very well.

Another adult male volunteer said about the instructors,

> They're very open; they have open minds. They're willing to do whatever they can to help everybody. I never saw them tell anybody "no" unless it was just something they couldn't do. And something I noticed with Mr. Ricky was that if he didn't know the answer, he would go and try to find it…and I like that because that tells me they have an interest in the kids and not just in their jobs. You know, some people go to work just to get a paycheck, some people go to work because they enjoy what they're doing and I see that in both of y'all.

He further commented that robotics instructors should,

> be a people person, you have to be able to deal with people because being in robotics involves competition, and with it being competition, sometimes tension gets a little high and being that leader, you have know how to step in and cool that tension and break it down where it doesn't get out of line. I think it's more friendly tension, but still it can get tough. Knowing how to handle a situation and get it under control, I think that's the biggest key.

The mother of two robotics youth said of the instructors,

> They're awesome; you have to have a love for what you do in order for ya'll to put up with all the stuff ya'll do there. I mean, it's amazing to me, it's somebody for everything, this is you all's calling. It is, but he's good, really good with the children to and patient. Patience is a virtue and you got to have that.

One 4-H administrator talked about what it took to lead a program such as robotics and said,

> First of all you have to have the right attitude. I don't know how you do it, but you manage to get the college student, the young students, that the kids look up to. That is real important. For someone so close to the 4-H age, to still keep that authority figure, but to still get on the level with the young people, that is an important factor to really allow the young people to have the kind of experiences…I've seen people in general, other departmental specialists; they were rude to the kids. Kids pick up on that real quick. Those individuals, you look at them and how these are the ideal personalities you want surrounding young people because they are like a magnet. They just draw kids to them.
>
> First of all they are very knowledgeable in what they do. The other side of that I see them making it fun and not being critical. If something they do doesn't work they don't say "Oh, that's not right!" They basically say, "Wait. Let's try it this way." So it's like the kid doesn't feel intimidated by getting it wrong. They feel relaxed. I didn't realize the impact those individuals would have working with the kids. I had to see it myself.

While there are many characteristics that participants felt robotics instructors should have there was only one thing they thought 4-H administration and Extension administration should have – money.

Summary

Chapter 4 presented the findings from interviews conducted with youth, volunteers, 4-H agents, and administrators. Their interviews provided insight into the motivational factors that influence participants towards the robotics projects. The data collection was guided by the six research questions that formed the perimeter of the study. A summary, conclusion, and recommendations for further study are presented in Chapter 5.

CHAPTER V

CONCLUSIONS AND RECOMMENDATIONS

Summary

The purpose of this study was to investigate factors that influenced motivational attributes of participants in the 4-H robotics program. In order to discover these factors, interviews were conducted with 4-H youth, volunteers, agents, and state-level administrators. Additionally, other data were collected through observation, document analysis, and examination of artifacts. In the process of data analysis, several themes emerged:

1. Intrinsic motivational factors, such as the desire and determination on the part of the participant
2. The intrinsic belief that robotics is "fun"
3. The extrinsic motivation of building the robot
4. The extrinsic motivation of participating in a contest
5. The extrinsic motivation of working together as a team and finding a place to belong within the group
6. The extrinsic motivation that robotics is a means to future success
7. A motivation in adults to create a future for their youth
8. A motivation in adults to encourage youth to succeed
9. Success as a motivational factor

10. Teamwork as a motivational influence

11. Ability to resolve conflict

12. Envisioning the end results

13. Robotics as means to fulfill dreams

14. Role of instructors

15. Role of administration

Conclusions

The participants in this study were quick to describe robotics as a "fun" activity. Everything about robotics was simply fun. As the interviews progressed, participants peeled back the layers of fun and revealed many important factors. The responsibility in interviewing these participants was great because they were vulnerable in sharing what made them participate in the robotics program. The youth shared dreams of future success, college, careers, houses, and families. The adults talked about their hopes for the future, a world they were preparing their children for but one they had never seen. The qualitative research method was critical in gleaning this information from participants.

By utilizing a bounded case study, the parameters of the research were established and the limits of the study delineated. Based on the bounded case study paradigm, the issue of motivation was able to be explored and provided a framework for both the research and the participants while simultaneously allowing participants the freedom to express what motivated them. This approach yielded informative anecdotes and insights that would not have been discovered if a quantitative approach had been taken. For example, the researcher would not have known to ask whether the dream of having a “nice house” was a motivating factor for youth since that particular factor had not been mentioned in previous research.

From collecting data, several interesting findings emerged to explain the underlying motivational attributes of participants in the robotics program:

1. Participants engaged in the robotics program for both intrinsic and extrinsic motivational reasons. Initially, participants were attracted to robotics because of their own innate interest in constructing something from nothing. Youth were drawn to the robotics program because of their desire to build a robot. Once they began building, they wanted to build the robot exactly like the robot in the instructions; they wanted the robot to be perfect. After they became more confident in their ability to build the robot, they began expanding on the instructions by adding different attachments, arms, claws, and so forth.

   However, that intrinsic motivation did not carry over into programming the robot. Programming the robot was considered to be the most difficult aspect of working with the robot and this is the point where extrinsic motivation is required to persevere. This would suggest that the robotics project requires a combination of both intrinsic and extrinsic motivation on the part of robotics participants.

2. Extrinsic motivational factors, such as working with teammates, planning for the future, envisioning the future, and participating in contests, were all extremely important extrinsic factors that influenced participants. The greatest extrinsic motivator was, of course, competition. The intrinsic

motivation that guided youth to building the most "awesome" robot was the opposite of the equation. Intrinsic motivation engaged the youth initially; extrinsic motivation to compete kept the youth moving toward each successive goal.

Competition was important to the youth because it gave them a platform on which to showcase their skills and hard work. Recognition of their hard work and victory was also a key motivational factor. Take into consideration that many of the youth who participate in robotics have few opportunities to be publicly recognized in front of their peers (i.e., homeschooled children, children not involved in athletics or other school organized events, such as band), then recognition takes on a special significance. The memory of the win was expressed in the physical representation of the plaque. While the youth liked the monetary reward, it was not their first choice. The memory of the victory was more important than the cash reward. The end reflected the beginning, meaning that when the youth talked about robotics they talked about how fun it was and how much they enjoyed competition but also that they hoped it would help them in college and with their future careers. Their memories and the knowledge gained will carry them through the years and build a foundation that they hope will result eventually in a "cash" reward—a college degree, a nice house.

3. Volunteers were motivated to participate in the robotics project because they saw it as a conduit for the success of their children. The success of a

volunteer was not in their educational background but in their willingness to explore new things alongside the youth. Further, their ability to, as one male volunteer said, "speak victory before it exists" was an essential component of being a successful robotics volunteer. Two of the volunteers interviewed had college degrees; one had completed some coursework towards a college degree; and the other five were high school graduates. One volunteer grew up in an Amish community with no access to electricity and yet was one of the best volunteers in terms of helping the children figure out how to build and program the robot. His teams placed first in both the junior and senior competitions.

Volunteers and state-level instructors had a considerable impact on youth as well. Their attitude toward the learning process, their knowledge, and their ability to connect with youth proved instrumental in influencing youth. The ability of youth to identify with instructors was also a critical motivational factor for youth and was noticed by administrators as influential.

4. Another key motivational factor for volunteers was providing safe activities for their youth. Finding positive after school activities was an extremely critical consideration for these parents. Research studies such as this one could help other volunteers understand the significance of introducing other youth to the robotics program.

5. Volunteers also felt that girls needed much more prodding to participate in robotics. Girls that persevered and indeed flourished in the robotics project

always had strong role models in their mothers or a female volunteer. These female volunteers almost always had a college degree if not an advanced degree like a master's or doctoral degree. In order for girls to succeed in robotics, strong role models are needed.

6. 4-H agents, parents, and volunteers all expressed the desire to see their youth be successful in future endeavors whether it was in college, a future career, or simply the ability to communicate more effectively with other people and speak in front of others. Adult participants felt that robotics was a conduit to other future success. Furthermore, parents often expressed the opinion that they were not sure what their child's future would look like or what type of career they could achieve but they had a deep desire to prepare their child as best they could for the unknown. One of their strongest motivators was to give their child the courage to work through difficult or unknown situations and reach a target goal. The results of the study would indicate that youth need to have attainable challenges to work through.

7. Another important motivational factor for parents was to provide a positive activity in which youth could participate. This meant that youth could work with others as part of a team to solve complex problems both on the contest mat and between one another. Creating positive youth relationships that worked was an important life skill and a positive aspect of working together.

8. Younger youth, ages 8–13, were able to describe building robots as "fun," and were able to express their passion for the robots when they enthusiastically described "building those awesome robots." It was easy to

identify their passion for robotics by the way they inched forward in their seats, the gleam in their eyes when describing their robot, the big hand gestures that accompanied their description of the robot, and the inflexion in their voice.

9. Robotics competition helped teach 4-H youth social as well as cultural awareness by using contests that reflect the history of Mississippi youth. It forced youth to engage in the world around them, whether it was solving problems from an oil spill or examining history through the eyes of the native Choctaw Indians.

10. The data also revealed that girls were slower to assimilate into the robotics project than boys. Interestingly, female adult volunteers and agents assumed that boys had a more natural inclination toward robotics. However, male volunteers expressed the view that their girls were just as capable as their boys. These same volunteers believed at the beginning that girls had a more supportive role and that the girls were primarily responsible for decorating. However, over time, these same girls came to dominate the design and programming aspects of the team. Programs such as robotics could possibly help to eliminate some gender stereotypes prevalent in STEM areas.

11. Another characteristic of female participants was that they typically started out as the "third wheel" on the team. Many were co-opted into the team because another person was needed for the three-to-four-person team-member requirements. Once on the team, they were quiet, withdrawn, and

shy. However, once the girls acclimated to the idea of robotics and were able to get in the habit of building and programming, most of the girls took the leadership role in the team.

Often girls expressed disgust with the boys for being off-task or goofing off. In one instance, one female team leader even took over the leadership role on the team because she and the male leader could not compromise on building and programming. The male participants tended to view the robot as theirs and everyone else on the team as a mere necessity to the team-member requirement. Most girls who stayed with robotics also became the best programmers on their teams, becoming the go-to person on the team and teaching younger members how to program. This would suggest that the robotics program can help girls develop leadership skills needed to take on leadership roles in their communities.

12. Even though girls demonstrated strong abilities in robotics, they did not see engineering as a career choice, unlike their male counterparts. However, most did feel that robotics would be helpful to their future careers.

13. An interesting finding from this study was that when participants were asked to discuss whether or not race played a factor, they unanimously viewed the question as referring to something bad. They did not think race was a factor but they associated the question of race with negative behavior. Participants responded that while race was not a factor the team from Alexander county were very unsportsmanlike.

14. As research in the literature review suggested, and this study concluded, competition was a hugely important extrinsic motivational factor that influenced youth and adults alike. However, recognition is front of peers was also critical to motivating youth to participate in robotics.
15. The robotics program introduced youth that had not previously been a part of the statewide 4-H program to 4-H. It provided a new audience for 4-H, youth not involved in the traditional 4-H activities such as agriculture and home economics. Robotics offers youth of all abilities a chance to flourish and thrive as they developed an understanding of who they were and what they could become. This research study helped to identify factors that influence youth to stay involved in robotics and can be used to help understand why some youth persist while others drop. This would also help identify ways to attract more youth to the project and retain these youth over the long term.
16. Administrative support of the robotics program was important, mostly due to their financial support. However, participants did not view administrators as having any motivational impact. The impact of administration would perhaps be felt more by the state-level instructors than 4-H'ers, parents, volunteers, and agents.

Summary

Motivational factors that influenced participants in the robotics project include (1) the desire to build and construct a robot, (2) competition and recognition, (3) desire for future success and security, (4) a safe place to participate and build relationships, (5) teamwork, (6) positive role models, and (7) encouragement. Understanding motivation is critical to building a robotics program. Discovering these factors or drivers at the micro level enables project leaders to create a comprehensive program that engages youth at multiple levels. Furthermore, this research helps identify the type of leader youth respond to and use as a role model. These role models provide encouragement that fuels the youth onward toward goals they did not think they could reach by themselves. Once the goals are accomplished, the youth have a feeling of accomplishment that fuels the desire to do more, to go further. By engaging the youth at both the intrinsic and extrinsic levels, the project leader can shape the robotics project to each child and help the child visualize possible future goals.

Recommendations

The results of the study generated new ideas and recommendations for strengthening the 4-H robotics project in Mississippi.

1. Provide a clear link between what youth are learning in the robotics project and how it connects to college majors as well as potential careers. Oftentimes, parents who have not had the opportunity to go to college have a deep desire for their child to go further than they themselves have gone. However, these parents are often unsure what steps have to be taken to help their child reach these goals. Providing a clear vision of the relationship between robotics and an eventual college major and career could prove useful in helping children and parents alike catch a vision for what could be.
2. Create a "road-map" game for youth to play. Youth often have a very narrow view of what the world has to offer or what it takes to thrive. For

example, many youth cannot budget for a mortgage, utilities, food, and so forth. This is further compounded for youth who have only known government housing, reduced or free lunches, and the use of food stamps. While there is nothing inherently wrong in the use of these, as the research stated, it can become an ingrained, generational pattern, and youth have a difficult time breaking the cycle. By creating the road-map game, youth can talk through potential road blocks, work through family and peer situations, and envision the end result.

3. Seek partnerships with other groups in the state, such as schools, Girl Scouts, Boys and Girls Clubs, and churches, to train adult volunteers in not only robotics which helps in mentoring youth. Training could occur in each of the four Extension districts with the possibility of bringing in specialized trainers from the National Robotics Academy from Carnegie-Mellon University. These trainers are the individuals who are actively involved in shaping national robotics trends and providing support for robotic programming languages.

4. Apply for grants and other funding sources to offset the expense of the robotics program. Robotics by nature is an expensive project, and the cost is often passed on to the parents. By securing grant money, fees can be offset or reduced. Furthermore, grants could allow for greater extrinsic motivational “carrots.” For example, if youth completed a certain task, they could be awarded “robot bucks” that translate into camp experiences or sharing robot bucks to buy a robot.

5. Create a robotics advisory council that includes 4-H agents, volunteers, parents, and youth to provide feedback on what aspects of the robotics program they find more engaging and motivating than others.
6. Hire eight college students or graduate students to work with a particular district. Each district should have two students assigned to it, and they should visit counties in that district to provide training, mini-camps, and volunteer workshops. Additionally, the eight students would form the foundation for mentors and staff at summer camps. Furthermore, a full-time position should be created to oversee the statewide robotics program. The advisory council should serve as consultants to the full-time staff member.
7. Create robotics ambassador positions, and select ambassadors from the pool of robotics youth (elected by other robotineers). These ambassadors should provide leadership to the robotics program at the county and district levels in addition to being role models for other youth.
8. Focus more resources and volunteer training on those working with Cloverbud (5–8) -age children. In particular, focus on after-school programming that targets young girls between kindergarten and first grade, the time that research shows most girls decide that science is not for them. As found in the review of literature, if young girls lose the motivation to build and explore by the time they reach first grade, it is difficult to motivate them toward robotics or STEM careers in middle school and high school.

9. Evaluate the newly designed robotics badge system from Carnegie Mellon to see whether it would enhance the extrinsic motivational attributes of 4-H youth.

10. Secure funding from outside sources to send first-place winners in the robotics competition to the national robotics competition at Purdue University.

11. Create a training plan for volunteers to progress through; work with administrators to develop this plan; and secure funding to implement it.

Suggestions for Further Study

From the data gathered, new ideas and suggestions for further study were identified.

1. A research study that examines the role of family or community groups on youth who participate in robotics needs to be conducted.

2. Since volunteers are such an integral part of the robotics program, the training and organization of the volunteers should be studied to match best instructional practices with adult volunteer learners.

3. Investigating the factors that lead to participants dropping out of the robotics program could also provide important information concerning barriers or roadblocks to participants engaging in the robotics program.

4. A longitudinal study that examines the impact of the robotics program as youth progress from kindergarten to college is needed. Questions it should address include the following: What classes do they take an interest in? How does their perception of self change over time as it pertains to their

capabilities in science and math? What type of college majors do they select? And what type of careers do they pursue?

5. A study that evaluates the correlation between the number of participants who engage in both the 4-H shooting sports project and the 4-H robotics project is needed. It was noted in the research that a large proportion of youth who participated in the robotics project also participated in the shooting sports project. Interviewed participants commented on the detailed nature of the two events and the link between them.
6. An extensive look at the role of teamwork in the motivational attributes of youth engaged in robotics.
7. A study that takes the findings of the research and converts it into a questionnaire that can be administered to all participants in the robotics project.
8. Further examine the effectiveness of using videoconferencing to conduct qualitative interviews with robotics participants as compared to face-to-face interviews.

Closing Remarks

The themes that emerged from this research formed a pattern of motivational factors that influenced participants. Interestingly, youth revealed a pattern that included a mix of both intrinsic and extrinsic motivational factors. Initially, most youth were drawn to robots from their own intrinsic desire to build a robot. However, extrinsic motivators were required to move 4-H'ers forward. These motivators included recognition of their work and placement at competition. The pattern or mosaic did not end for the youth at the culmination of the competition with a trophy or blue ribbon. By the time the youth reached 15–18 years old, they had internalized the success and the experiences to form a new intrinsic motivational level that seemingly propel them to college and future careers. The college degree or career is an extrinsic motivator for the internalized intrinsic motivation. It forms a circular pattern that carries the youth from eager learner to confident young adult.

In conclusion, the 4-H robotics program is a highly motivating activity. Youth are motivated to engage in a difficult task in a nonthreatening, informal learning environment where they can take their time discovering the engineering principles behind robotics as well as learning fundamental programming techniques. Furthermore, the robotics program provides many intangible motivational factors, such as the ability to motivate young people to see a difficult task through to completion, working with others, developing the courage to interact and speak in front of groups, and the belief that they are capable of pursuing degrees and careers in science, technology, engineering, and mathematics. Perhaps the greatest contribution of the robotics program is exposing youth to the possibilities of what could be. It is hard to be motivated to do something, to be something, if you have never seen it for yourself.

If Mississippi is to be competitive in the 21st Century global economy, Mississippi youth must have the opportunity and the resources available to pursue informal educational activities, such as 4-H robotics. The 4-H robotics program allows youth additional time out of the traditional school setting to explore and engage in STEM-related activities. As the review of literature stated, schools alone cannot be responsible for meeting the growing need for STEM development. Furthermore, the 4-H robotics program allows students to identify with activities and careers that they view as a viable option for their future. All of the youth interviewed expressed a desire to go to college and return to their hometowns, or close to their hometowns, to find work after college. Mississippi has long been plagued by the inability to keep its talented, well-educated students in state as there is a lack of available jobs and competitive pay. However, we must have the workforce in place to attract businesses that can bring higher paying jobs.

This is a sentiment repeated again and again by the adults. They want their children equipped to meet the demands of a changing world. The parents themselves may not have gone to college, they may not even have a full-time job, but they are intrinsically motivated to equip their child as best they know how. For the parents, the extrinsic motivators are undefined, far away, a hope of what could be. It is the internal push for their child to have a better life that fuels the desire to reach those extrinsic motivators like a college degree or a good job.

For the youth who participate in the 4-H robotics project, it can possibly become a pathway to future success. It is the desire to invest the hard work and energy today so they will have the foundation in place for their dreams to be realized. For volunteers, agents, and administrators it is the ability to "speak victory" into lives of their youth.

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APPENDIX A

INTERVIEW GUIDE FOR SEMI-STRUCTURED INTERVIEWS

Interview questions will begin with basic demographic information:

1. How old are you?
2. What grade are you in?
3. Where do you go to school?

The interview will then involve a series of open-ended questions designed to elucidate the perspectives and opinions of the interviewee:

1. Are 4-H youth intrinsically or extrinsically motivated to participate in robotics? Do youth participate for the "fun of it" or because of the challenge, or are they being prompted by external factors? Do perceptions of the robotics project differ on whether or not youth identify more strongly with intrinsic or extrinsic motivational factors?
2. What motivates volunteers to help 4-H youth participate in robotics projects? What type of volunteer are they (civic, church, or educational)? Do the volunteers have careers or experiences that lend themselves to mentoring youth in robotics? What do they hope to accomplish by encouraging youth to participate in robotics when compared to other projects (shooting sports, horse, sewing, etc.)?
3. Are the factors that motivate 4-H boys different than those that motivate 4-H girls? Comparatively, are the ratio of boys and girls in robotics projects relative to the ratio of boys and girls in other projects? Are there a hidden assumption that only boys do robotics? What barriers do girls face when participating in robotics? What motivates girls to participate in nontraditional project areas?

4. What role if any does race play in the motivational attributes of 4-H'ers, volunteers, agents, and stakeholders?

5. What was the role of varying factors of motivation in success? What does "success" in the robotics project mean for the youth, agents, volunteers, and stakeholders? How was success measured or viewed? What do they perceive their motivational factors to be that will lead them to success?

6. What role do administrators have in promoting robotics, and how are those efforts perceived by youth, volunteers, and staff at the county level? At the state level what are the administrators' reasons for promoting robotics? Was it a cohesive effort or fragmented?

APPENDIX B

IRB APPROVAL

September 13, 2011

Mariah Smith

Computer Applications

Mailstop 9662

RE: IRB Study #11-196: Gearing Up for Success, Motivational Attributes of 4-H Participants Engaged in Robotics: A Critical Perspective

Dear Ms. Smith:

This email serves as official documentation that the above referenced project was reviewed and approved via administrative review on 9/13/2011 in accordance with 45 CFR 46.101(b)(1). Continuing review is not necessary for this project. However, any modification to the project must be reviewed and approved by the IRB prior to implementation. Any failure to adhere to the approved protocol could result in suspension or termination of your project. The IRB reserves the right, at anytime during the project period, to observe you and the additional researchers on this project.

Please note that the MSU IRB is in the process of seeking accreditation for our human subjects protection program. As a result of these efforts, you will likely notice many changes in the IRB's policies and procedures in the coming months.

These changes will be posted online at http://www.orc.msstate.edu/human/aahrpp.php**. The first of these changes is the implementation of an approval stamp for consent forms. The approval stamp will assist in ensuring the IRB approved version of the consent form is used in the actual conduct of research. Your stamped consent form will be attached in a separate email. You must use copies of the stamped consent form for obtaining consent from participants.**

Please refer to your IRB number (#11-196) when contacting our office regarding this application.

Thank you for your cooperation and good luck to you in conducting this research project. If you have questions or concerns, please contact me at cwilliams@research.msstate.edu or call 662-325-5220.

Sincerely,

Christine Williams, CIP

IRB Compliance Administrator

cc: James Adams (Advisor)

APPENDIX C

IRB CONSENT FORMS

Dear Research Participant,

I am asking your permission to interview you as part of a research project geared towards understanding motivational factors of youth who participate in 4-H robotics projects. This form is designed to give you information about this study. I will be more than happy to describe this study to you and answer any of your questions.

Project Title: *Gearing Up for Success: Motivational Attributes of 4-H Participants Engaged in Robotics: A Critical Perspective*

Principal Investigator: *Mariah L. Smith, Extension Instructor*
Computer Applications and Services
Email: mariahs@ext.msstate.edu
Telephone: 662.325.3226

Faculty Advisor: *Dr. Jim Adams, Associate Professor*
Department of Instructional Systems, Leadership and Workforce Development
Email: jadams@colled.msstate.edu
Telephone: 662.325.7563

The purpose of this research is to investigate what factors motivate 4-H youth to participate in the robotics project. I will ask you a series of questions over a thirty minute time frame. The interview will take place at the local county Extension office.

There are no expected risks or discomforts associated with your participation in this research. This research will enable us to determine what factors motivate youth to participate in robotics and what inhibits youth from participating. By identifying these factors we can develop strategies and lessons aimed at helping youth succeed in the robotics project and simultaneously look for ways to reduce or remove barriers.

The interviews will be recorded (video/audio) for transcription purposes. The recordings will be kept in a locked filing cabinet for 3 years. After the allotted time, the recorded media will be destroyed.

Sincerely,

Mariah L. Smith

MSU IRB
Approved: 9/13/11
Expires: —/—/—

Informed Consent for Adults

You will never be identified by name, location, or identifying characteristics in the research or subsequent articles or presentations. All names of participants will be changed to protect their identity. Taking part in this research is completely voluntary, you may refuse to participate or stop at any point in time during the interview. There are no negative ramifications if you decide not to participate.

If you have any questions regarding this research you may contact me by email: mariahs@ext.msstate.edu or by telephone: 662.325.3226. For questions regarding your rights as a research participant, or to express concerns or complaints, please feel free to contact the MSU Regulatory Compliance Office by phone at 662-325-3994, by e-mail at irb@research.msstate.edu, or on the web at http://orc.msstate.edu/participant/.

Statement of Consent to be Recorded

Please sign below if you are willing to have your interview recorded *(audio and video)*. You may still participate in this study if you are not willing to have the interview recorded.

Signed: ______________________________

Date:______________________________

Statement of Consent

If you agree to participate in this research study, please sign below:

Your Signature______________________________ Date________

Your Name (printed)______________________________

You will be given a copy of this form to keep for your records.

This consent form will be kept by the researcher for at least five years beyond the end of the study.

MSU IRB
Approved: 9/13/11
Expires: –/–/–

Informed Consent for Parents

Dear Parent,

I am asking your permission to interview your child as part of a research project geared towards understanding motivational factors of youth who participate in 4-H robotics projects. This form is designed to give you information about this study. I will be more than happy to describe this study to you and answer any of your questions.

Project Title: *Gearing Up for Success: Motivational Attributes of 4-H Participants Engaged in Robotics: A Critical Perspective*

Principal Investigator: *Mariah L. Smith, Extension Instructor*
Computer Applications and Services
Email: mariahs@ext.msstate.edu
Telephone: 662.325.3226

Faculty Advisor: *Dr. Jim Adams, Associate Professor*
Department of Instructional Systems, Leadership and Workforce Development
Email: jadams@colled.msstate.edu
Telephone: 662.325.7563

The purpose of this research is to investigate what factors motivate 4-H youth to participate in the robotics project. I will ask your child to a series of questions over a thirty minute time frame. The interview will take place at the local county Extension office.

There are no expected risks or discomforts associated with your child participating in this research. This research will enable us to determine what factors motivate youth to participate in robotics and what inhibits youth from participating. By identifying these factors we can develop strategies and lessons aimed at helping youth succeed in the robotics project and simultaneously look for ways to reduce or remove barriers.

The interviews will be recorded (video/audio) for transcription purposes. The recordings will be kept in a locked filing cabinet for 3 years. After the allotted time, the media will be destroyed.

MSU IRB
Approved: 9/13/11
Expires: –/–/–

Page 1 of 2

Please sign below if you are willing to allow your child to have his/her interview recorded *(audio and video)*. He/She may still participate in this study if you are not willing to have the interview recorded.

☐ I do not want to have this interview recorded.
☐ I am willing to have this interview recorded:

Signed: ________________________________

Date:________________________________

Your child will never be identified by name, location, or identifying characteristics in the research or subsequent articles or presentations. All names of participants will be changed to protect their identity. Having your child take part in this research is completely voluntary, you (or your child) may refuse to participate or stop at any point in time during the interview. There are no negative ramifications if you or your child decides not to participate.

If you have any questions regarding this research you may contact me by email: mariahs@ext.msstate.edu or by telephone: 662.325.3226. For questions regarding your rights as a research participant, or to express concerns or complaints, please feel free to contact the MSU Regulatory Compliance Office by phone at 662-325-3994, by e-mail at irb@research.msstate.edu, or on the web at http://orc.msstate.edu/participant/.

You will be given a copy of this form to keep for your records.

Statement of Consent
I have read the above information, and have received answers to any questions I asked. I consent for my child to take part in the study.

Your Signature________________________________ Date________

Your Name (printed)________________________________

Signature of person obtaining consent________________________________ Date________

Printed name of person obtaining consent________________________________

This consent form will be kept by the researcher for at least five years beyond the end of the study.

MSU IRB
Approved: 9/13/11
Expires: –/–/–

Page 2 of 2

4-H Youth Assent Form

Your parent knows we are going to ask you to participate in this research project. A research study is a way to learn more about people. We want to know about kids' attitudes/experiences about robotics. It will take thirty minutes of your time to complete the interview. Your name will not be written anywhere in the research. No one will know these answers came from you personally.

If you don't want to participate, you can stop at any time. There will be no bad feelings if you don't want to do this. You can ask questions if you do not understand any part of the study.

Do you understand? Is this OK?

Name (Please print):____

Signature: ____

Date: ____________________

Is it OK if I videotape our interview?

☐ I do not want to have this interview recorded.
☐ I am willing to have this interview recorded:

Signed: ______________________________

Date:______________________________

Investigator's Signature: ______________________Date:__________

MSU IRB
Approved: 9/13/11
Expires: –/–/–

APPENDIX D

LETTER OF SUPPORT FROM 4-H STATE PROGRAM LEADER

MISSISSIPPI STATE UNIVERSITY
EXTENSION SERVICE

State Program Leader
4-H Youth Development

September 12, 2011

IRB Board
Mississippi State, MS 39762

RE: Research on 4-H Robotics Program Proposed by Mariah Smith

TO WHOM IT MAY CONCERN:

After reviewing the overview of the research proposed by Mariah Smith to investigate the motivating factors in the 4-H robotics program, I support the investigation that is focusing on successful involvement as it relates to the youth participating.

The identification of the perceived motivational factors that lead to successful involvement in the 4-H robotics program can provide program in-sight for increasing the Mississippi 4-H program enrollment and roll in the increased positive impact in Science, Engineering, Technology and Math (STEM) programming through experiential education. With the need for greater competency in STEM one of the goals of the overall 4-H program can be closer to attainment, that of developing life-long learners.

It is an honor to support this research and we are excited to see the results of this study.

Sincerely,

Susan L. Holder
State Program Leader
4-H Youth Development

4-H is a community of young people across America who are learning leadership, citizenship, and life skills.

Cooperative Extension Service • Mississippi State University
Box 9844 • Mississippi State, MS 39762 • Phone (662) 325-3352 • Fax (662) 325-2098

F1109 (07-11)

MISSISSIPPI STATE UNIVERSITY
EXTENSION SERVICE

Computer Applications and Services

July 6, 2011

Dr. Susan Holder
State Program Leader, 4-H Youth Development
Box 9844
Mississippi State University, MS 39762

Dear Dr. Holder,

As you are aware the 4-H robotics program has seemingly taken on a life of its own with more and more 4-H'ers participating in the program. Though we have seen some anecdotal evidence to support the robotics program, we have not at this point conducted any formal research in this area. With your permission, I would like to engage in a qualitative research project to determine the motivational factors that influence 4-H youth, volunteers, and agents to participate in this program. This would require that I interview 4-H agents, parents, and youth in their county. Naturally, permission would be sought from all involved and parental consent would be requested prior to interviewing minors. Both the names of the counties and the participants involved would be changed to protect their identity. I would also like to utilize information from the 4-H ES-237 reports with your permission. The data that would be requested is the overall number of 4-H youth and volunteers, their demographics, and number of youth enrolled in STEM project areas.

This research will further the scant body of work being done in the area of 4-H youth and robotics projects. Currently, most of the research is being conducted by Bradley Barker of Nebraska. Additionally, it will enable Mississippi 4-H to better understand what draws young minds to the field of robotics and it will also help to identify barrier to engaging in the robotics program. I appreciate your consideration of the matter. Please do not hesitate to call or email should you have further questions.

Sincerely,

Mariah L. Smith

I have read and understand the information presented in the research proposal entitled, "Gearing up for Success, Motivational Attributes of 4-H Participants Engaged in Robotics: A Critical Perspective." All of my questions have been answered to my satisfaction and I agree to allow the researcher, Mariah L. Smith, to conduct this study.

Dr. Susan Holder, State Program Leader — Date: 9-1-2011

Cooperative Extension Service • Mississippi State University
Box 9662 • Mississippi State, MS 39762-9662 • Phone (662) 325-3226 • Fax (662) 325-8761