Summer 8-13-2010

Is Competition Making a Comeback? Discovering Methods to Keep Female Adolescents Engaged in STEM: A Phenomenological Approach

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Is Competition Making a Comeback? Discovering Methods to Keep Female Adolescents Engaged in STEM: A Phenomenological Approach

By

Kathryn Betz Notter

A DISSERTATION

Presented to the Faculty of
The Graduate College at the University of Nebraska
In Partial Fulfillment of Requirements
For the Degree of Doctor of Philosophy

Major: Educational Studies
(Instructional Technology)

Under the Supervision of Professors James King and Allen Steckelberg

Lincoln, Nebraska
August, 2010
Is Competition Making a Comeback? Discovering Methods to Keep Female Adolescents Engaged in STEM: A Phenomenological Approach

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University of Nebraska, 2010

Advisors: James King and Allen Steckelberg

The decreasing number of women who are graduating in the Science, Technology, Engineering and Mathematics (STEM) fields continues to be a major concern. Despite national support in the form of grants provided by National Science Foundation, National Center for Information and Technology and legislation passed such as the Deficit Reduction Act of 2005 that encourages women to enter the STEM fields, the number of women actually graduating in these fields is surprisingly low. This research study focuses on a robotics competition and its ability to engage female adolescents in STEM curricula.

Data have been collected to help explain why young women are reticent to take technology or engineering type courses in high school and college. Factors that have been described include attitudes, parental support, social aspects, peer pressure, and lack of role models. Often these courses were thought to have masculine and “nerdy” overtones. The courses were usually majority male enrollments and appeared to be very competitive. With more female adolescents engaging in this type of competitive atmosphere, this study gathered information to discover what about the competition appealed to these young women.
Focus groups were used to gather information from adolescent females who were participating in the First Lego League (FLL) and CEENBoT competitions. What enticed them to participate in a curriculum that data demonstrated many of their peers avoided? FLL and CEENBoT are robotics programs based on curricula that are taught in afterschool programs in non-formal environments. These programs culminate in a very large robotics competition. My research questions included: What are the factors that encouraged participants to participate in the robotics competition? What was the original enticement to the FLL and CEENBoT programs? What will make participants want to come back and what are the participants’ plans for the future?

My research mirrored data of previous findings such as lack of role models, the need for parental support, social stigmatisms and peer pressure are still major factors that determine whether adolescent females seek out STEM activities. An interesting finding, which was an exception to previous findings, was these female adolescents enjoyed the challenge of the competition. The informal learning environments encouraged an atmosphere of social engagement and cooperative learning. Many volunteers that led the afterschool programs were women (role models) and a majority of parents showed support by accommodating an afterschool situation. The young women that were engaged in the competition noted it was a friendly competition, but they were all there to win.

All who participated in the competition had a similar learning environment: competitive but cooperative. Further research is needed to determine if it is the learning environment that lures adolescent females to the program and entices them to continue in the STEM fields or if it is the competitive aspect of the culminating activity.
Dedication

To Maria Gabrielle Betz Notter,

I hope you always see the humor in life and have the courage to follow your heart.
Acknowledgements

This could not have been accomplished without my family. My parents, Luz de Maria and Edward Betz Sr., who have instilled in me that all things are attainable with education and perseverance. Thank you to my sisters, Deb and Pamela who have given endless encouragement during this journey and for all the last minute flights into town to watch Gabs so I could focus on the current task at hand.

Many thanks to my committee members: Dr. James King, Dr. Allen Steckelberg, Dr. Gina Matkin, and Dr. John Creswell for the guidance and stamina through this voyage. Special thanks to Dr. Creswell for helping me lift up the true essence of this study.

Friends have been integral in this process, Jan for taking off her counseling hat who just listened when I was in the crying stage. To my dissertation group; Heath, Terry and Dave thank you for all the meetings that kept us on track, the many pep talks, and words of encouragement. Though we had no “special” name, this group will always be special to me.

To my husband, Patrick, for all the nights I was studying, reading or researching I thank you for just “handling” all things and for reassuring me, ever so calmly, “it’s just part of the process.”

Last but not least to Gabby, for being so patient through the years of this program. One day you will fully understand why this was so important to not just me, but to us. “No I can’t tonight, Mommy has to study,” has now officially become a phrase of the past.
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Chapter One

Background

Since 1994, the American Association of University Women (AAUW) and National Science Foundation (NSF) have invested nearly $90 million to fund projects intended to increase gender equity in STEM (Science, Technology, Engineering, and Mathematics) fields (AAUW, 2004). Despite national support in the form of grants provided by National Science Foundation, National Center for Information and Technology and legislation passed such as the Deficit Reduction Act of 2005 that encourages women to enter the STEM fields, the number of women actually graduating in these fields is surprisingly low. This is demonstrated by the number of Computer Science (CS) degrees awarded to women which dropped nearly 20% since 1985 (National Center of Educational Statistics, 2008). Other research supports these findings with 43% fewer graduates and 45% fewer CS degree enrollments in 2006/2007 than in 2003/2004 (Computer Research Association, 2008).

Women represented just 17% of Advanced Placement (AP) computer science exam takers in 2008, the lowest representation of any AP exam. Women hold more than half of all professional occupations in the United States but fewer than 24% of all computer related occupations. These are just two of the reasons the National Center for Women Information Technology (NCWIT) was established in 2004 with startup funding from the National Science Foundation, Avaya, Microsoft, Qualcomm, the Kauffman Foundation and others to increase women’s participation in information technology.

Over the past 20 years, one mission of the National Science Foundation was to offer support of science and engineering education from grade school (pre-K) to beyond
graduate school. The U.S Department of Labor’s 2018 work projections show that significant training in math and science will be needed for future occupations. The reason for integrating research funding with education is to help ensure the United States will continue to have plenty of skilled people available to work in new and emerging scientific, engineering and technological fields. The economy of the United States grows more and more reliant on a technological workforce (National Council for Research on Women, 2001). We can not afford to overlook half of our population. Using this domestic resource of underutilized female potential, our nation could once again be a leader in global competitiveness (Raphael, Bachen, Lynn, Baldwin-Philippi, & McKee, 2006; Tan, 2002; Weber & Custer, 2005). Low representation of women in postsecondary computing education is a major national concern (Cohoon & Aspray, 2006; Varma & Hahn, 2008). The shortage of women in computer science has serious consequences for women’s education and for the loss of productivity and innovation necessary for the advancement of science and technology (Jackson, as cited in Singh, 2007; National Center for Women & Information Technology, 2005). Notwithstanding deep implications for the United States’ preparedness and competitiveness, women offer a different perspective to the STEM development areas (Margolis, Fisher, & Miller, 2002). Attracting more women to STEM can maximize innovation, resourcefulness and competitiveness.

As stated by Margolis, Fisher, and Miller (2002) women and men each bring something different to the table with computer work. As described in the AAUW report (2010) Why So Few, male engineers working on designs for automotive airbags, designed
the bags to meet specifications of the male body. These designs led to avoidable deaths for women and children.

Margolis and Fisher (2002) have illustrated that women’s voices have literally not been heard in the design process demonstrated by early voice recognition software that was calibrated to male voices only. Adding a feminine perspective can allow for different innovation and design processes, which may lead to products and services that could provide more gains for a larger population.

According to Scott Anderson of NASA, the last time the United States saw a vested interest in STEM fields was after the first moon landing in 1969. “Today just under half of the scientists and engineers at NASA could retire if they wanted to” Anderson told THE Journal (Demski, 2009, para 1). Department of Labor Statistics (2009) predicts that women will account for more than half the increase in total labor force growth between 2004 and 2014. The need for engineers and computer scientists is predicted to grow just over 30% by 2018 (Department of Labor, 2009). The need to establish other home grown available resources is becoming more critical to the United States. Women are an underutilized resource. Ensuring that female adolescents have the proper exposure to science, technology, engineering and mathematics fields is vital.

**Statement of the Problem**

Why aren’t more women pursuing careers in science, technology, engineering and math? Many studies have focused on how female adolescents have been discouraged when taking STEM coursework. The results of these studies suggest it is not just one factor that deters young women from this line of coursework, but many. Home influences link access to computers and attitudes displayed by parents can reflect a child’s perceived
ability for computer skills (AAUW, 1991; Mawson, 2007; Messersmith, Garrett, Davis-Kean, Malanchuk, & Eccles, 2008; Mumtaz, 2002). School influences (Imhof, Vollmeyer, & Beierlein, 2007; Sanders, 2002), social aspects and peer pressure of technology courses (Imhof et al., 2007; Jenson, de Castell, & Bryson, 2003; Williams, 2007) appear to be grounds for determent. During early adolescence peer pressure can weigh heavily on decisions of some students. Stigmatisms of being seen as nerdy or masculine (Brunner & Bennett 2002; Margolis & Fisher, 2002; Nicolosi, 2002) for wanting to take STEM related courses are usually avoided. Research suggests the lack of role models (AAUW, 2004; Bart, 2000; Lee, 2003; Messersmith et al., 2008; Nicholls, 2007) bear a major responsibility with the decline in young women taking courses in the STEM fields.

Female graduation rates in the sciences have always appeared low, so why the recent concern? With the potential of our nation becoming a lesser global economic leader, fostering “homegrown” talents has become a must. Our most valuable assets are our human resources. The United States needs to foster the potential of all STEM participants in order to meet the challenges of global competitiveness. According to the National Science Foundation Subcommittee on Science, Technology, and Space (2004), the Committee Report warned that our failure to invest in science and to reform math and science education was the second-biggest threat to our national security.

Results of many studies have concluded there is a need for more participants in the STEM fields; targeting minorities may be the answer. The National Academy of Sciences (2005) also supports our need of well trained individuals in the STEM areas. Many programs have been developed over the past few years. The Committee on Equal
Opportunities in Science and Engineering (CEOSE) in their 2004 *Decennial & 2004 Biennial Reports to Congress* stresses the low participation rate for STEM fields is at an all time critical level. Though the number of Bachelor’s degrees has tripled over the past 40 years (National Science Foundation, 2007) the same is not true for those seeking degrees in STEM fields. Research demonstrates the need for targeting women and other minority’s participation. Twenty first century standards which drive the critical elements of the American educational system mandates students should be engaged with the real world data, tools, and experts. Today, many efforts to make science and engineering more inclusive are focusing attention on the multiplicity of “pathways” by which persons from underrepresented groups can enter and progress through STEM careers (CEOSE, 2004). In order to create these pathways, focus must fall upon what attracts young women to science, technology, engineering and mathematics; and what makes these young women want to stay engaged in these curricula.

The downward trend of graduates in the STEM fields especially computer science is of serious concern with the Department of Defense (DARPA report, 2010). With the nation lacking in numbers of STEM graduates, female adolescents are an obvious choice that could grow the number of graduates in science, technology, engineering and mathematics fields. Establishing links between how girls view STEM curriculum, learning situations and eliminating the barriers when confronted with STEM activities may provide the connection needed that will encourage young women in the STEM fields. One possible method for reaching female adolescents might be informal learning strategies or after school programs.
Jane Butler Kahle (1996), founder of Discovery, a NSF funded program many years expired, stated that girls are drawn to math and science through cooperative settings rather than competitive, individual approaches. The Discovery program was the spring board for Operation SMART launched in 1985, by Girls, Inc. to encourage hands-on based inquiry. This program was an informal learning approach that followed the basic principles of assuming girls are interested in math, science and technology, letting girls make big mistakes allowing for risk taking and building of confidence in personal abilities, helping girls resist the notion of sex-stereotyped courses or careers and expecting girls to succeed (Girls Inc., 2010). Self conducted studies claim Operation SMART has demonstrated favorable attitudes of girls toward science, these results come from self-assessments. There have been many questions regarding the validity of self-assessments. According to Ross (2006), some participants of self-assessment modules may rate themselves higher based on higher self-efficacy and intrinsic motivation. Therefore the soundness of attitudinal studies has been questioned.

Informal learning strategies have the potential to address issues surrounding barriers associated with home and school influences, social and peer aspects while providing role models for students. Research indicates informal learning encourages and enhances social and academic achievement by cooperative learning and social interaction (Deen, Bailey, & Parker, 2001; Slavin, 2000). Informal learning has been an important component of education in our culture since the late 18th century (Bell, Lewenstein, Shouse, & Feder, 2009) where libraries, churches, and museums were seen as institutions concerned with public education. All of these structures encouraged exploration and dialogue among the public. Cross (2007) defines informal learning as a process guided by
the learner. This process involves the learners setting their own learning objectives and learning what they feel they need to know. Proof of learned skills is demonstrated by their ability to do something they could not do prior and is usually demonstrated through formal assessments. Informal learning consists of observing others, asking questions, sharing stories and having casual conversations with other learners.

Within informal education there are often two learning paradigms; informal and non-formal learning. Usually these terms are used interchangeably, but according to Eshach (2007), informal learning happens relatively spontaneously with no authority figure or mediator. Non-formal learning usually happens at institutions beyond the classroom (science museum, zoo, and planetarium). In addition, non-formal learning is structured, usually adult led and supported by curriculum that can be sequential or non-sequential.

Conversely, in the non-formal learning environments there is little rigidity in organization structure that would prevent innovation. For example, non-formal organizations, like 4-H or Boys and Girls Clubs of America, rely on volunteers to lead educational experiences. To support innovations, new volunteers can be recruited and existing volunteers retrained. Volunteers enjoy a degree of flexibility not found in formal education. However, volunteers may not possess the typical background content knowledge and educational skills of certified teachers. Therefore, greater instructional resources are frequently needed for the training and development of volunteers. Finally, unlike formal learning environments, where criterion-reference tests are routine, data collection in a non-formal environment is an ongoing challenge to implement, due to
time, support and training constraints. With the need for more scientists and engineers, there needs to be a concerted effort to overcome these limitations.

Informal learning environments can stimulate science interest, build learners’ scientific knowledge and skill, and—perhaps most importantly—help people learn to be more comfortable and confident in their relationship with science.

Educational programs focused on science learning take place in schools and community-based and science-rich organizations and include sustained, self-organized activities of science enthusiasts. Such programs are growing in number, with the support of significant federal funding, and there is mounting evidence that structured, non-school science programs can feed or stimulate the sciencespecific interests of adults and children, may positively influence academic achievement for students, and may expand participants’ sense of future science career options. (Bell, 2009, para 19)

As pointed out by Bell (2009), the mounting evidence of the non-formal learning situations are effective for engaging science interests. Increasing the opportunity for students to become involved in STEM courses would seem to be the direction to follow. Clearly there are benefits and tradeoffs between scaling in a non-formal environment as compared to the formal education environment typically occurring within schools and school districts. Scaling (or scaling-up) is the process of broadening the level of instruction and curriculum. One apparent benefit is there is no systemic reform movement in the non-formal environment. Often scaling-up an intervention fails in the schools since the intervention fails to take root or they are not sustained because classroom teachers find the interventions inconsistent with their local practices and norms (Blumenfeld, Kempler, Krajcik, & Blumenfeld, 2006; DARPA, 2010). Furthermore, teachers are often resistant to changes in practice that originate at the district or state level and are filtered down to the classroom level (Blumenfeld et al., 2006). In addition,
organizational rigidity in the formal education system may leave little room for innovation (Cohen & Ball, 2007).

Classroom experiences can be determining factors for attracting students and keeping students engaged in the STEM fields (MacDonald & Korinek, 1995). Papert (1993) believed robotics instruction is an example of a curriculum that could have had potential to increase classroom learning; however robotics instruction has yet to become an important part of mainstream classrooms instruction. Outreach efforts by universities and K-12 instruction can increase student interest in STEM fields by way of informal or non-formal learning experiences, especially for those who did not find the appeal in the traditional classroom experiences with science, math, engineering and technology coursework. As stated by Phillip Bell (2009) in his committee report to Congress on The Role of Informal Environments and Experiences in the Learning of Science,

STEM academic achievement in school, although crucial, is only part of what is needed to cultivate personal expertise in STEM—and the activities with which people engage in informal learning environments are an equally crucial platform for STEM learning. This point highlights the truly complementary role of schooling and informal learning environments in STEM learning. (Bell, 2009, para 5)

“Non-formal educational situations” as defined by Barker, Nugent, Grandgenett, and Adamchuck (2009) are adult guided learning activities outside the classroom that demonstrate strong potential for stimulating interest in STEM curriculum. The “Robotics and GPS/GIS in 4-H: Workforce Skills for the 21st Century” project is such an educational process; learning is mediated through a volunteer in an afterschool program. The long term goals of this program are to foster interest in STEM, basic technology skill development, inquiry based problem solving and encouraging teamwork. This follows a similar approach to informal learning. Literature abounds with reasons female
adolescents deviate from STEM courses. Several organizations consistently describe programs that help guide female adolescents to the STEM path as very successful, however little data is found to support such claims. Data supporting the linkage of informal learning to potential continued female participation in STEM fields is thin.

By using an informal learning model with an after school robotics program geared toward female adolescents, several of the influences that deter young women from entering STEM coursework may be ameliorated. Informal or non-formal learning strategies have been in use for many years; Boys and Girls Clubs of America and Girl Scouts are two such clubs focusing on problem solving and strategizing real life issues. One promising way of promoting STEM in informal learning environments is the use of educational robotics (Barker, Nugent, Grandgenett, & Hampton, 2008).

4-H robotics competition stimulates problem-solving techniques while the group environment encourages cooperative learning. As studies suggest, social aspects of coursework are more favorable to girls (AAUW, 2004). Robotic coursework uses socialization and teamwork to enhance the learning process. This has the potential for creating positive social aspects, positive school influences and potential role models, especially if the instructors are women. Using educational robotics within informal learning environments may have the potential to impact female participation in robotic curricula; enhancing problem solving, demonstrating construction and programming skills in a non-competitive environment all lead to an outreach program more enticing and conducive to learning styles of young women (Ashby, 2006; Barak & Mesika, 2007; Fairweather, n.d.).
Graduates in STEM fields are declining. Women in particular are not entering STEM fields. Research has described reasons female adolescents may be dissuaded from STEM coursework. My research will focus on hearing the voices of female adolescents who chose to enter STEM related coursework, by way of the robotics competition.

**Purpose of the Study and Research Questions**

The purpose of this qualitative study was to describe the experiences of girls and young women who have competed in the First LEGO League and CEENBoT competitions. The aim of this descriptive qualitative study was to determine what influences participation of some young women in the Nebraska robotics competition via the 4-H robotics curriculum using non-formal teaching styles. The First LEGO League and CEENBoT competitions are held yearly. These competitions conclude a year-long curriculum that has been taught by volunteers in after school settings. The researcher used a purposeful selection of young women that completed the First LEGO League competition of the LEGO Mindstorms NXT robotics platform and GPS/GIS program through a large Midwestern university. The objective of this study was to determine what excited these female adolescents about wanting to be a part of this curriculum and competition.

The research questions that guided this study were:

1. What are the factors that encouraged participants to participate in the robotics competition?
2. What was the original enticement to the FLL and CEENBoT programs?
3. What will make participants want to come back and what are the participants’ plans for the future?
Delimitations and Limitations

Data were gathered at the LEGO League competition, the culminating activity for the LEGO curriculum and was limited to those who competed in the LEGO League competition. The data gathered from participants were from that day only. Not all participants of the Year 1 and Year 2 LEGO Mindstorms NXT robotics platform and GPS/GIS curriculum competed in the final competition. The researcher was limited to individuals who were in attendance on the competition day. Those who agreed to participate were for the most part self-selected. This data was gathered in small focus group settings. Even with the focus groups consisting of only four-six young women, there was a risk of interviewing participants who were not as vocal as others, therefore I did run the risk of not hearing everyone’s story. The young women who were involved in the focus groups have a year or more invested in the robotics informal learning program, data may have been skewed. Motivation for these female adolescents could possibly be higher than young women who were not involved in the competition.

One unforeseen limitation involved parents of homeschooled participants. These parents insisted on being part of the focus group in which their daughters participated. I was not expecting this to be an issue, they readily signed the needed consent forms and entered the focus group room. These parents were interested in what their daughters had to say. I questioned the female participants to ensure they would give honest feedback with these adults in the room. The participants assured me they would be honest and open with answers to the mediator’s questions.
Significance of the Study

Determining the factors that entice middle school female adolescents to take part and continue with educational programs centered on robotics in Nebraska can increase the capacity to attract more young women to science, technology, engineering and mathematics (STEM) academic and career fields. Our nation stands to gain the most from increasing our numbers of graduating scientists and engineers. Others that could benefit from the study include program coordinators, after school facilitators, 4-H programs, girls clubs, and anyone interesting in promoting STEM as possible career paths through informal and non-formal programs. Establishing proven strategies that help engage young women in STEM activities has the promising effect to increase the flow of young women to the STEM fields via other informal learning situations or non-formal learning venues.

As mentioned previously many research articles have determined external and internal influences perpetuate the leaky pipeline (departing from STEM coursework and careers); as a result of prior research, many organizations have implemented after school programs or clubs (i.e., Boys and Girls Clubs of America, Club Girlstart, and Girl Scouts) who claim to enhance STEM participation, but conclusive data are not available. Majority of results are derived from attitudinal surveys, but do not illustrate whether continued participation in STEM fields is an outcome. Closer looks at these programs follow in my literature review. Other organizations like SMART Girls Club, sponsored by the YMCA, focus on building adolescent self-esteem thereby attempting to empower girls to make “smart” choices. Findings demonstrate self-esteem plays a factor in STEM participation (Baumeister, Campbell, Krueger, & Vohs 2003; Gürer, & Camp, 2001), but that is not the focus of this research.
Weinberg, Pettibone, Thomas, Stephen, and Stein (2007) study targeted a short term robotics program and its impact on female adolescent’s perception of their abilities. The results were favorable, stating “well structured programs can effectively modify social and cultural beliefs [and] may be particularly promising in encouraging girls to pursue STEM areas for study and careers” (Weinberg, et al, p. 4, 2007).
Chapter Two

Literature Review

As with any phenomenological study, the literature review is incorporated into sections and researched after themes are identified within the data analysis chapter. In-depth knowledge before data gathering may bias the collection process. As noted by Patton (2002), “reviewing literature can present a quandary in qualitative inquiry because it may bias the researcher’s thinking and reduce openness to whatever emerges in the field” (Patton, 2002, p. 226).

This chapter represents a selected review of relevant literature specific to robotic curricula and how informal learning processes impacts the ratio of female adolescent participation in these curricula. The literature reviewed helped to establish the theoretical framework for this study: to describe the lived experiences of female middle school participants, as they compete in an educational robotics competition; what led them to participate in STEM activities and the effectiveness of robotics and this competition as a tool to help young women to become more engaged in science, technology, engineering and mathematics (STEM).

Though research has been done regarding female participation in STEM fields, little has been completed that directly link robotics curriculum and robotic competitions with female adolescent involvement in the science, technology, engineering, and mathematics fields. The literature review provided a deeper understanding of issues surrounding lack of young women’s participation in the STEM fields and verified the need for this qualitative approach. The topics of this chapter cover interrelated concepts; prior research findings of why female adolescents avoid STEM coursework including
internal and external influences, lack of mentors to influence career path selection and how classroom learning environments may be more detrimental to encouraging female adolescents in STEM coursework.

**External and Internal Influences**

Parental influences as suggested by Jacobs and Eccles (2000) may affect their children’s values by constructing a socio-emotional climate, providing experiences, acting as role models and conveying their perceptions and expectations. Messersmith et al, (2008), states parents and peers were significant factors in career-related choices for the adolescents in their study. The use of role models may spark observational learning (Bandura, 1986) which may cause the observer to emulate behaviors. Majority of researchers have used the words role model and mentoring interchangeably. For the purpose of this study, the words mentor and role model will be used interchangeably with the meaning, a person known or unknown who is a good example to follow.

In a report by Sanders (2006), role models and mentors were clearly defined. In her research, Sanders maintains mentoring could be defended with evidence however the same was not true for correlating a positive relationship between STEM and role model intervention. Maton and Hrabowski (2004) and Summers and Hrabowski (2006) agree that mentoring evidence is mounting and shows promise for effectively promoting positive attitudes with math and science in after school programs; these researchers substitute role model for mentor and vice versa. Sanders (2006) stated evidence was demonstrated by data correlating advancement in women’s STEM careers with mentoring, i.e., a science mentor working with high school or college students. Messersmith et al. (2008) and the findings in the AAUW 2004 report also support the
notion that encouragement from mentors and role models were significant reasons to continue or pursue STEM coursework. Role models who show determination, hard work and perseverance appear to be the best sources of inspiration. Quimby and DeSantis (2006) question if role models alone are the reason for inspired success or it is due to the self-efficacy that is indirectly influenced. This is a valid question but not one I am seeking to answer through this research.

Many factors may weigh into the external influences; exposure to various courses, clubs, and social groups allow adolescents an opportunity to broaden their horizons and exposure to activities that may be outside their normal scope. For some adolescents options when selecting coursework or after school clubs may play a key factor in later career choices. As mentioned by Fredricks, Alfeld-Liro, Hruda, Eccles, Patrick, and Ryan (2002), adolescents often engage in similar activities with friends; doing this may fulfill a need for relatedness, in other words feeling like they belong. Along with locating friends who share similar likes in activities, adolescents gravitate to those who share the same ideas about future education (Kiuru, Aunola, Vuori, & Nurmi, 2007). This has the potential to lead to numerous activities and experiences within the STEM fields. This age bracket (adolescents in grades six through ten) has shown an increased interest in thinking about their future education and potential career path (Eccles, Vida, & Barber, 2004). By establishing relationships with students wanting to be involved with STEM activities, possible career options may extend to those who may have not considered science and math fields (NSF, 2003; Barnett, 2004).

Peer pressure is thought to be one of the most significant factors in most decisions made in an adolescent’s life. It is usually during adolescence that individuals begin fitting
the mold of acting like girls or boys and doing things that are considered feminine or masculine. Computer courses are thought to be more masculine (Crombie, Abarbanel, & Trinneer, 2002) than other courses offered. This social construct can be restyled by parents; parents need to let their daughters know they can be “girly” and technical (Gürer & Camp, 2001). While peer pressure is at an all time high during the adolescent years, research indicates attitudes can change given the proper role models to follow (CEOSE, 2004; George, 2000; Powell, 2005). A low self-esteem has a strong correlation to succumbing to peer pressure. Baumeister, Campbell, Krueger, and Vohs (2003) conclude high self-esteem will cause people to persist longer in the face of failure. Young women reported not participating in computing courses and robotic clubs in high school since they did not appear to have superior computer skills the boys reported. Without strong convictions, girls are reticent to pursue computer classes/clubs if their fellow participants are to be socially disconnected geeks who only talk about computers (AAUW, 2000; Margolis & Fisher, 2002).

Research by the National Center of Education Statistics (2008) shows that, in fourth grade, the number of girls and boys who express a fondness for math and science is approximately equal. By eighth grade, twice as many boys as girls show an interest in these subjects and test scores revealed young women on average tended to score lower than their male classmates. Though a small gender gap persists within the SAT and ACT math sections (Halpern, Benbow, Geary, Gur, Hyde, & Gernsbacher, 2007) a recent study by Hyde and Mertz (2009) shows little difference is apparent with average math performance between boys and girls on standardized tests. However, among girls and
boys who perform equivalently, girls typically display a lower level of confidence in their abilities (AAUW, 2010).

Sanders (2006) noted boys rate their confidence levels higher than girls even if they are not particularly advanced in subjects ranging from English to computer literacy skills. Evidence provided of “fixed mindset” (Blackwell, Trzesniewski, & Dweck, 2007; Dweck, 2008; Dweck & Leggett, 1988) may prove to be the cause of girls not feeling as confident as they might. Academic abilities are not fixed and the power of effort is a significant factor (Dweck, 2008; Halpern, Aronson, Reimer, Simpkins, Star, & Wentzel, 2007) to anyone attempting to learn. By a mentor, parent or teacher building confidence expressed through encouragement, clear expectations of success and praising effort identified as work and diligence, confidence levels can be raised and persistence enhanced.

Women, who have a misconceived mindset that they cannot expand their knowledge base, especially for computer science track majors, soon drop from the programs (AAUW, 2010) because they feel the coursework is “innate” to some and they are lacking the “natural talent” of the field. Though some show promise of natural talent (Dweck, 2008), math and science are learned skills not just inborn to the gifted. Stipek and Gralinski (1996) concurred that endorsing learning goals implies a belief that one’s ability is changeable through effort. The brain should be thought of as a muscle (Dweck, 2008) that needs to get regular exercise and sometimes pushed to the limits. By strengthening this muscle it has the ability to acquire new knowledge. As stated by Good, Rattan, & Dweck in AAUW’s *Why so Few?* (2010), when young girls are told they have
a “growth mindset” which is the ability to learn and process new information, no achievement differences can be seen when compared with male counterparts.

**Informal and Non-formal Learning Styles**

Research demonstrates it is not one issue that will keep girls from STEM fields but a culmination of many issues. Informal and non-formal learning styles help to address many issues seen in the daily formal structure of the classroom environment. If competition (Funk, 2003; Morris & Daniel, 2008) and isolation (Hewlett et al., 2008) were leading factors that detract girls from STEM programs, the openness and sharing environment of non-formal learning situations would prove to be beneficial. Non-formal learning styles provide a non-linear, cooperative learning social group (Campbell, 2001). Informal learning gives autonomy to the learner in a social setting. With informal learning, the teacher’s role must be redefined. The teacher will need to become part of the learning community; learning is placed in the hands of the learner, without interference of the teachers (Smilde, 2009). Teamwork becomes a necessity and building block for success with non-formal learning structures.

Robotics curricula emulate this philosophy and configuration. Smilde (2009) implies teachers must be learners with the students and near equals for learning to occur. Most instructors in the robotics curriculum are not practiced with technology nor are they experts in the curriculum, usually all instructors are volunteers who commit because of their belief to be an effective part of the program (Liao-Troth, 1999).

**Programs that Promote STEM Advancement for Young Girls and Women**

As noted in Chapter One, women have been a lacking demographic in the STEM fields for many years resulting in studies and creation of programs to address this issue.
These programs have varying techniques of attempting to reach the female adolescent population.

GenTech is one such program, located at www.shecan.com, is a "gender, inclusive pedagogy and technology" research project whose mandate is to create conditions within which girls and women have maximum access to, and confidence in, a wide range of new information technologies (www.shecan.com). This program appears to be a wonderful start, however, the website still reflects conferences held in April 2008 and recent publications are dated 2003.

Other programs that appear to be successful include Storytelling Alice and Rapunsel.org. Storytelling Alice was created by Kelleher, Pausch, & Kiesler (2007) at Carnegie Mellon. This program targets female adolescents by teaching programming skills by creating a storyline using drop and drag instead of a text-based programming language. Since this Alice’s deployment, Kelleher, et al, have created Alice 2.0 and reports success with girls and their programming skills. Brown’s (2007) findings discovered Alice was a resource hog and trying to fix bugs was a laborious task. He found the most concerning issue was the inability for his students to transfer their knowledge of GUI interface to actual text-based programming languages.

Rapunsel.org is a single-player dance game, programming skills are taught by making a figure on the page dance. Rapunsel was specifically designed to teach underprivileged girls how to program computers (Flanagan & Nissenbaum, 2007). Using gaming as a model this program was more “girl friendly” than such titles as Grand Theft Auto, which teaches negative community values. Carter (2006) noted in her research that males were more likely to “game” than young women. Carter also claimed that most
young women are not attracted to gaming nor are they attracted to the formal teaching practices that were used to teach programming skills.

Girl Start is a program that is based in Austin, TX whose mission is to empower girls in math, science and technology (website http://www.girlstart.org/values.asp). The afterschool programs are designed to increase girls’ confidence in math, science, engineering and technology and encourage them to pursue higher education and careers in these subjects. However the last survey completed in 2004 revealed only an 8% increase in both attitude toward STEM and interest in continuing STEM activities. Club Girl Start uses HTML and game creation as a method to enhance adolescent STEM awareness. A competition is the culminating activity for Project IT within the Club Girl Start program. This competition involves local area businesses in which these young women enhance a feature of the company.

The Jason Project (http://www.jason.org/public/whatis/jason.aspx) is not focused on female interventions but for all students, including at risk students. The Jason Project curriculum uses multimedia as a method of engaging students in “real science” (Goldenberg and Heinze, 2003). The project stresses the use of hands-on activities and multimedia to reach all students. Through assessments, attitudes were shown to increase toward science and careers of scientists.

**Educational Robotics/robotic Competitions**

There are several educational robotic competitions held annually in the United States. The majority of these competitions focuses on social needs and developing skill sets that will enable the youth in these programs to be forward thinkers, demonstrate critical thinking skills and have the ability to adapt for changing conditions. A component
included in the robotics curricula nationwide are solutions to real life problems. Some of the ideas generated within these competitions were refrigerators that kept inventory of food supplies and a toilet that was able to diagnose heath based on human waste products. Piotrowski and Kressly (2009) had students using the LEGO Mindset team members to discover the best robotic improvised explosive devices (IED) removal technique. IEDs are a real life problem in our world. These curricula focus on using technology and critical thinking skills to overcome everyday challenges.

Learning takes place when it is meaningful, challenging but appropriate to developmental level, and social interaction is accepted; robotics competitions have the capability to bring all these factors together as a learning tool (Barak & Zadok, 2007; Bers & Portsmore 2005). Furthermore, Hussain, Lindh, and Shukur (2006) and Barker and Ansorge (2007) stressed the advantages in robotics projects to cultivate creativity, problem solving skills and teamwork. The LEGO Mindset kits are liked by the participants of the robotic curriculum. Since the LEGO building block has been around for more than 50 years, the sets look very familiar to most students. By using these sets in the curriculum the students are more engaged in active inquiry by creating playful experiences (Barker & Ansorge, 2007; Bers & Portsmore, 2005).

**Summary**

To summarize, many researchers have gathered information for reasons why adolescent and career oriented women have surrendered to the leaky pipeline (departing from STEM coursework and careers). Clearly there is cause to be concerned with the lagging numbers of graduates in our science and engineering fields, especially when the proposed job market in 2018 states that nine out of ten jobs will need extra training in
math and science (Department of Labor, 2009). The damages are reversible, given we pay heed to making the necessary changes. The NSF submission by Weinberg, Pettibone, Thomas, Stephen, and Stein (2007) details programs designed to encourage and enhance women’s participation in STEM fields. The programs studied by Weinberg, et al (2007) ranged from software design to robotics competitions. Their findings demonstrate the programs are successful at attracting female participation, but most do not address the issue of long term engagements for women in the STEM areas. Many reports discuss methods of enhancing female participation in science, technology, engineering and mathematics fields, but conclusive data is elusive. Of the many factors that cause attrition from STEM fields, research has noted that competition never appeared to be an endearing factor to the way girls learn due to the nurturing aspect of the female disposition.

My literature review reiterated the many aspects that deter women from continuing with STEM fields, if they indeed begin. The research is lacking data that connects enhanced and continued participation in the STEM fields once a robotics curriculum and competition is experienced. With the ever expanding FLL and other robotic competitions, this researcher believes competition needs to be reevaluated as a model within the robotics program that will keep female participants connected to STEM fields. We have a clear understanding of why young women don’t continue in the STEM pipeline. As noted earlier in my review, lack of role models, attitudes, social aspects and peer pressure all have parts to play. Using qualitative methodology, this researcher focused on what attracted female participants to a robotics curriculum and does it have the power to keep them engaged? What is it about the robotics curriculum that entices female participation?
Chapter Three

Methodology

Introduction

This chapter describes the research approach in this qualitative study. The intent was to gather data that described the experiences of the girls at this robotics competition and how it affected their interest in STEM activities as told in their own voices.

Assumptions and Rationale for a Qualitative Study

The purpose of qualitative study is to seek out personal experiences as a way to better understand an individual’s perspective of a given phenomena, in this instance the phenomena was the robotics competition. Qualitative research produces findings that cannot be determined by statistical procedures (Strauss & Corbin, 1990) but focuses on an exploratory method to gather data from individuals. Exploratory data collections seek to describe a behavior (Bryant, 2004). Assumptions put forth by Merriam (1988) admit the researcher is primarily concerned with the process, is interested in deriving meaning, and is the primary instrument for the data collection. Merriam (1988) also states the research involves fieldwork, is very descriptive and very inductive. Qualitative design is naturalistic, meaning the fieldwork takes the researchers into the setting of the participants. Notes are taken with paper and pencil or video/audio recording devices to capture the full experience of the participants (Bogdan & Bilken, 2007).

I decided the phenomenological tradition was the best representation for my study for two main reasons. First, while similar robotic programs exist and claim successes with female participants by encouraging their commitments to STEM careers, these programs are lacking conclusive data. The data gathered focused on attitudinal surveys or
perceived cognitive increases; these surveys were self guided therefore results may be hindered by personal biases. Second, quantitative numbers cannot describe the essence of why these young women chose to participate in this competition.

**Rationale for Phenomenological Tradition Rationale for Qualitative Design**

Qualitative design is needed in this research to ensure the researcher acquires the stories that are relayed by the female participants. There are five qualitative traditions. Creswell (2007) describes these traditions as narrative, grounded theory, case study, ethnography, and phenomenological.

**Table 1**

*Types of Qualitative Traditions and Major Attributes of Tradition*

<table>
<thead>
<tr>
<th>Types of Qualitative Traditions</th>
<th>Major Attribute of Tradition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Narrative</td>
<td>Reports the life of a single individual</td>
</tr>
<tr>
<td>Grounded theory</td>
<td>Moves beyond describing or reporting but acts to generate or discover a theory</td>
</tr>
<tr>
<td>Case Study</td>
<td>Focuses on one or more cases within a bounded system</td>
</tr>
<tr>
<td>Ethnography</td>
<td>Focuses on entire cultural group</td>
</tr>
<tr>
<td>Phenomenological</td>
<td>Describes the meaning of several individuals and their lived experience of a concept or phenomenon</td>
</tr>
</tbody>
</table>

Source: Qualitative Inquiry and Research Design (Creswell, 2007).

A phenomenological approach was taken since all participants had shared a common experience of the phenomenon (Creswell, 2007). The researcher was striving to gain insight as to why these girls were drawn to the robotics and GIS/GPS programs. After year two of participation they were heavily invested in the program and most
participants of the robotics competition were attending their second competition. Using the phenomenological inquiry, the researcher had gathered data that gave the participants their own voice, describing the phenomena of the competition. The researcher tried to ascertain information demonstrating potential factors that may encourage other girls to participate in similar robotics informal learning settings. According to Moustakas (1994, p. 84), evidence from phenomenological research is derived from first-person reports of lived experiences. Phenomenology describes the meaning of experiences lived by several individuals and seeks to understand the essence of that experience (Hatch, 2002).

The researcher was present with each focus group to listen and observe the first hand stories from each participant. Being a participant observer I was able to see and hear each participant’s reaction to the questions. I was able to read into facial expressions and determine through body gestures comfort levels of the participants while being interviewed. Nothing should be taken for granted or overlooked by the qualitative researcher (Bogdan & Bilken, 2007). The smallest details have given valuable insight into this researcher’s field notes.

Table 2 presents a visual representation of Moustakas’ qualitative tradition of phenomenology as compared to the steps taken by this researcher in accordance with the same qualitative tradition.

Epoche as defined by Moustakas (1994, p. 85) is a process of setting aside predilections, prejudices, predispositions and allowing all things, events, and people to enter anew into consciousness, and to look to see them again, as if for the first time. The first step of data analysis is epoche, freeing myself of all suppositions (Husserl, 1977)
Table 2

*Qualitative Traditions of Phenomenology*

<table>
<thead>
<tr>
<th>Moustakas Preparing to Collect Data Model</th>
<th>Researcher Actions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Formulate the question</td>
<td>Previous pilot projects conducted by this researcher involving college aged women who are currently majoring in STEM curricula, helped to determine questions for the female adolescents participating in this study.</td>
</tr>
<tr>
<td>Conduct literature review and determine nature of study</td>
<td>Literature review was conducted to determine gaps in the research. Interrelated concepts such as internal and external influences, mentors and classroom settings appear determining factors in whether adolescent girls decide to take STEM extracurricular coursework. Data linking robotics curriculum/competitions and informal learning styles having the ability to engage female adolescents in STEM curriculum is thin. All participants experienced the same phenomenon, the robotics competition and the related coursework to be part of the competition. It was determined that focus groups would be the most effective way to extract data from the participants.</td>
</tr>
<tr>
<td>Develop criteria for selecting participants</td>
<td>The researcher used purposeful selection of participants. The First LEGO League competition is held only one day a year. The participants involved in this study were part of the competition. The researcher approached competitors as they registered for the day’s events to hand out fliers and answer questions regarding focus groups that would be conducted that day to gather data from the participants. All participants signed an assent form (Appendix D), due to the ages of the participants, their guardians signed a consent form (Appendix C); both were approved through the IRB process (Appendix B).</td>
</tr>
<tr>
<td>Develop instructions and guiding questions for phenomenological research interview</td>
<td>A script was prepared for the mediator to follow which ensured the same questions were asked to all focus groups. See Appendix G for a sample transcript.</td>
</tr>
</tbody>
</table>

Table 2 continues
<table>
<thead>
<tr>
<th>Moustakas Collecting Data Model</th>
<th>Researcher Actions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Engage in the Epoche process to assist in creating an atmosphere and developing rapport for conducting the interview</td>
<td>I engaged epoche by leaving biases behind, I focused only what the participants were describing as their personal experiences. The mediator for the focus groups was much younger than the researcher, in hopes that rapport might be developed faster due to limited time with participants. The mediator who is not involved with STEM fields brought no biases to the focus groups. I positioned myself in the research in the role of the researcher section.</td>
</tr>
<tr>
<td>Bracket the question</td>
<td>Due to my strong interest in the phenomenon being studied, I carefully bracketed my experiences and personal biases. I revisited my personal experiences in my section on reflexivity.</td>
</tr>
<tr>
<td>Conduct qualitative interview</td>
<td>Focus groups were conducted on the day of the competition. Twenty-seven participants met in various sized groups in a room removed from all aspects of the competition. See Appendix F for Focus Group questions.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Moustakas Organizing, Analyzing and Synthesizing Data Model</th>
<th>Researcher Actions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Develop individualized textural and structural descriptions</td>
<td>Each theme begins with a quote that is directly linked to the completion, followed by textural and structural depiction of the phenomenon experienced by the participants of this study.</td>
</tr>
<tr>
<td>Essence</td>
<td>The essence of this study is the empowerment of these female adolescents through the positive experience of the competition as it coexists with the robotics curriculum. The combined shared experience of the competition was excitement, energy, and the desire to have this experience over and over again. This curriculum and competition taught strategies that focused on achievement through engaged effort. By exposing these young girls to the hundreds of other students both male and female, it lessened the stigmatisms associated with science, technology, engineering and math.</td>
</tr>
</tbody>
</table>

Table 2 continues
### Moustakas Summary, Implications and Outcomes Data Model

| Summary of Study | With the continual need to enhance the number of our home grown production of scientists, engineers and technology specialists, we need to stop focusing on what keeps young women out of the STEM curricula but what will get them in. My findings include my participants like the competition; they like the notion of working in teams but love the thrill of completion. They echo findings that role models and parental support are very important. This group had similar attitudes as previous pilot project participants. They were comfortable with their own way of thinking and were not afraid to follow what makes them happy. |
| Relate study findings to and differentiate from findings of literature review | Many findings demonstrate external and internal influences strongly affect female adolescents in STEM choices. Parents (Jacobs & Eccles, 2000; Messersmith, Garrett, Davis-Kean, Malanchuk & Eccles, 2008) and role models (Sanders, 2006; Maton & Hrabowski, 2004; Quimby & DeSantis, 2006) play significant factors in choices these adolescents make. Quimby & DeSantis (2006) if role models are the true reason for success or if self-efficacy is a more logical approach. Informal and non-formal learning styles may be the solution to engage adolescents in programming and other computer science related skills. Most programming curricula begin with hard core programming. According to Parviainen (2008), initial programming classes deter women from pursuing STEM fields. The informal learning styles teach programming but not hard core, the learning styles of the LEGO robotics curriculum is hands-on, cooperative, fun and adds excitement through mini competitions. Educational robotics using LEGOs have been around for several years. This method of teaching STEM curricula cultivates creativity, problem solving skills and teamwork (Haussain, Lindh, & Shuku, 2006; Barker & Ansorge, 2007). The gap in the literature lies in connecting the positive aspects of informal or non-formal learning styles (that address lack or role model, parental support and social interaction for female adolescents) and the robotics curriculum that may entice young women to pursue STEM careers. |

*Table 2 continues*
Moustakas Summary, Implications and Outcomes Data Model (cont’d)  

<table>
<thead>
<tr>
<th>Researcher Actions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Relate study to possible future research</td>
</tr>
</tbody>
</table>
| Relate study to personal/professional outcomes | This study has both professional and personal implications for me. Being a female technology director at a large Midwestern university, I feel it is imperative I remain active as a mentor to female adolescents through various organizations and clubs. I will continue to be actively engaged in removing stigmatisms associated with STEM careers.  

On the personal side, I will demonstrate to my daughter that nothing is out of bounds, everything is attainable. This study and other pilot projects I have been involved with have exposed me to strong willed individuals who have the ability to make tough choices to follow their personal aspirations. I hope to instill this attribute in my daughter and all other young women who have the desire to march to the beat of a different drum. |
| Researcher’s future direction and goals | Throughout my academic career, I have not wanted to focus on the research aspect of a faculty position. I will remain on the administrative course; however, I intend to continue to provide mentoring and advance my research through publications as a secondary researcher. The need to track these young women as they make their way through college and on to professional lives is very important and needs to be documented and I will gladly assist others as they continue to research this field. |

Source: Phenomenological research methods. (Moustakas, 1994).

All personal experiences of the researcher have been bracketed in order to obtain a fresh, new perspective that is not tainted by the researcher’s personal history. This is a very important step since most phenomenological studies are research initiated by a strong personal interest or passion. The researcher must be careful to not allow this personal interest bias the study (Marshall & Rossman, 1999). By setting aside personal
knowledge, as much as one can in order to clearly hear the descriptions of the
participants, several expected themes emerged with a couple unexpected which I will
describe in Chapter 4. Though my personal interest did not bias my research, I have made
several annotations and observations from my personal experiences that either clarify or
question findings in this data.

Using Morgan’s *The Focus Group Guidebook* (1998) to guide my process, I
determined focus groups would be the method used to gather data from the participants.
The researcher has had reasonable experience and high comfort level working with focus
groups and other qualitative projects. The researcher has also concluded several graduate
level courses that emphasized qualitative research design and analysis. Qualitative
research allows for “rich, thick description” (Creswell, 2008) from participants. Through
this thick, rich description, the researcher can delve deeper into issues and find surprises
that come from listening to the participants’ voices. The participants provided the
researcher with a new perspective.

**Research Questions**

The purpose of this qualitative study was to describe the experiences of young
women who competed in the First LEGO League and CEENBoT competitions. The aim
of this descriptive qualitative study was to determine what influenced participation of
some young women in the Nebraska robotics competition via the 4-H robotics curriculum
using non-formal teaching strategies, ie after school programs or clubs. The majority of
literature produced thus far examines why female adolescents are not participating in
STEM activities. By hearing the stories told by the participants’ competition it was this
researcher’s hope to unveil the reasons if/why the competition held enticement for continued STEM participation.

In previous pilot projects the researcher interviewed college women who grew up in the Midwest and are currently enrolled in STEM curriculum at a local university. My research questions were guided not only by literature reviews but from previous interviews from these pilot projects. The FLL competition was not available to these older interviewees, but having experienced similar deterrents in their journey to college majors, I felt their input was relevant. My research questions included:

1. What are the factors that encouraged participants to participate in the robotics competition?
2. What was the original enticement to the FLL and CEENBoT programs?
3. What will make participants want to come back and what are the participants’ plans for the future?

Using Creswell (2007) as a guide to qualitative research, the researcher will look at the holistic picture and analyze the participants’ words all in the natural setting of the competition trials.

Focus Group Questions

1. When and why you did first start doing this (tinkering with robotics, science activities, and math activities?)

2. Tell me about your experiences and what led you to this competition. Share any funny stories that you, friends or family may have about your involvement in this competition?
3. What is the most fun thing you did at this competition or getting ready for this competition?

4. What things have been supportive? What things have been challenging?

5. Describe what made you feel good about this competition?

6. Are there other questions I should be asking the other girls?

Interview questions were open-ended in nature. Open-ended responses allowed the participants to create their options for responding (Creswell, 2008). The focus groups lasted 35-40 minutes in length. There were four focus groups, all but one were competition participants only. One focus group had several homeschooled students in which their mothers wanted to be part of the focus group questions. All focus groups met in the same room away from the main areas of competition. Each focus group session lasted for approximately 35-40 minutes. The focus groups met for a very limited amount of time. In that time, I needed to ensure a comfortable relationship was established between the participants and the researcher. I purposely chose a mediator who was younger than the researcher in hopes that the participants would feel more comfortable and therefore speak more freely. The mediator of the focus groups is employed by a local school district working with special needs children. She has had prior experience with facilitating other research projects and working as a mediator in other focus groups. The mediator was a very energetic individual. I had many reasons to select her; prior experience was key, however another major factor for selecting her involved her lack of experience with STEM related coursework. The mediator’s unbiased view of stories being shared by the participants was a way for the researcher to ensure epoche was in place.
Research Participants

The population of this study were female participants in the Nebraska Robotics Expo:FIRST LEGO League Competition and CEENBoT Showcase. The student participant number totaled 308, with 33% young women. Each team had at least one adult coach or a sponsor with them. The focus groups varied in size from five participants to eleven. A total of four focus groups were conducted. I attempted to keep the number in the group to five, however, when several sponsors discovered I was conducting focus groups, they were eager to have at least one member of their team participate. The students were also very excited to be part of the focus groups. Their responses to seeing me were evidence of their eagerness to participate. “There she is, there she is! We need to go over there now!” My participant pool was self selected therefore I waited near the gift shop to see who was willing to participate in the focus group. Not everyone who showed up was chosen to be in the focus group. Having a willing participant pool made selection easier on the researcher. The demographics of most girls in this competition are far from diverse; with majority of participants white middle class status living in average Midwestern towns. The number of females participating in the focus groups totaled 27.

Data Collection Procedures

The researcher followed the steps set forth for a phenomenological study set by Moustakas (1994). First, the researcher should understand the perspective behind the phenomenon. Having taught computer literacy for over 15 years to this age group and remaining in the technical field in which there are very few women, I understand the need to engage more young women in the STEM fields.
Second, research questions were designed to capture the stories of the road traveled to participate in this competition. These questions were more than just collecting data. The situations were created to encourage opinions, ideas, personal perceptions and emotions. Since a primary emphasis behind qualitative research is to understand the world from the perspective of those living it (Hatch, 2002), I felt it was appropriate to collect data during the final competition of the First LEGO League and CEENBoT competitions. These information rich participants were the reason for the purposeful sampling. This competition is the culminating event for the year long robotics curriculum provided by the University of Nebraska 4-H Department. The middle school females that were part of my study were participants in the First LEGO League and CEENBoT competitions that are held once a year.

As participants and their parents arrived for the event, I meandered through the crowd asking if they had girls as part of the team and if they would like to be part of my focus group sessions. I briefly explained the purpose of the focus groups and the time involved. If the coaches, sponsors or female competitors showed interest, I handed assent forms (Appendix D) to the female participants and consent forms (Appendix C) to their parents. I explained that all information was confidential and no one’s name would be attached to any information that was to be shared. I instructed adults and students where I would be located if they were willing to participate in the focus groups. Of the potential participants that wanted to partake in the focus groups, I purposely selected the first group of young women, making sure teammates were not in the same focus groups.

As the day unfolded and the events concluded, I gathered six girls to create the first focus group. The competition end times staggered, allowing the researcher to have
four focus groups. The room reserved for the focus groups was a distance from the competition area. As they entered the focus group session, I collected the needed consent forms. The young women who did not have signed consent forms from a parent were turned away from the focus group session. I had many willing participants and filling the focus group sessions was not a problem. According to Morgan (1998) three-five groups are recommended depending on the “moderate diverseness” of participants. The selection process was a convenience sample selection. There were a few who clearly showed discomfort when approached and asked to join a focus group. As a result they chose to not participate in any focus group sessions. These individuals suffered no consequences related to the competition of the FIRST LEGO League (FLL) Competition and CEENBoT Showcase.

Third, in-depth focus groups were conducted to gather detailed accounts from the participants. The researcher and a mediator participated in each focus group. I was a participant observer taking field notes as the mediator asked questions. I was careful to select young women who were from different teams to reduce the chances of any one member of the focus group being overshadowed by a teammate. I felt it was very important for everyone to have the chance to tell their own story. The focus group session began directly after I introduced myself, the mediator, recapped the intent of the focus group and the process for confidentiality.

**Focus Groups**

The use of focus groups is primarily exploratory. The phenomenological interview involves an informal, interactive process and utilizes open-ended questions (Moustakas, 1994). Several assumptions are present within phenomenological studies;
including the primary focus is on the lived experience of the participant, the experience is meaningful, and the information gathered is highly descriptive (Morse & Richards, 2002). Phenomenological research does not seek to explain, but to gather the stories from these individuals. I helped to create concentrated conversations that focused on what attracted each participant to the robotics curriculum and the competition. As stated earlier, I was a participant observer which allowed me to become immersed in the setting. Using the method of focus groups I was able to gather a substantial amount of data in a short period of time. Focus groups are advantageous when interaction among participants would likely yield the best information (Creswell, 2008). Through group discussions I was able to generate active comparisons of opinions and experiences as told by the participants. Specifically, the research will explore how informal STEM activities like the FIRST LEGO League contribute to young girls pursuing additional STEM experiences in informal learning environment.

The female participants were given pseudonyms and will remain anonymous to protect their identities. After all competitions were completed every registered competitor participated in the post-assessment administered by University of Nebraska. This was a follow-up to the pre-assessment test to determine attitudinal and cognitive significance, if any, administered at the beginning of the robotics curriculum. All participants received one of several prizes given away.

**Data Analysis Procedures**

The fourth step in conducting a phenomenological study was data analysis. Epoche, which is setting aside personal perspectives and preconceived ideas (Creswell, 2008; Hatch 2002, Moustakas, 1994; Patton, 2002), is the first phase of the analysis.
process. By engaging epoche, I was able to listen to each focus group with an unbiased perspective. This was critical to ensure I was hearing the stories that were being relayed.

This study examined information from participants that described their personal experiences culminating in the competition of the robotics curriculum through a series of interview questions. Each participant discussed her experiences and involvement with the competition and events leading to the competition. Participants readily shared their personal experiences, perceptions of the competition, curriculum and personal stories that they felt were significant. Each focus group held lively discussions with even the most reticent individuals participating.

Each focus group conversation was transcribed and added to MAXqda. Field notes were also transcribed and added to MAXqda for further review. Field notes (Appendix H) contained what the researcher heard, saw and various thoughts during the course of collecting data. I also added personal reflections during the process. The researcher used a transcriber who signed a confidentiality form (Appendix E) adhering to the rules set by the Institutional Review Board (Appendix B).

The researcher used a data analysis program to organize the next several phases of phenomenological analysis process. I used MAXqda qualitative data analysis software to unearth participants themes and to organize field notes, comments, and thoughts. Though this process could have been handled with pen and paper, I chose MAXqda software to simplify grouping all of my documentation in one location.

MAXqda software allows the researcher to color code text and offers the use of other visual tools to guide the analysis process. This software allowed the researcher to input valuable field notes and memos while continually correlating themes throughout
several transcripts. With the availability of add-on pieces to the software more granular, refined analysis was an option. MAXqda ensured data organization that allowed retrieval of codes, themes and other correlations without removing items from their original source.

With qualitative research it is easy to gather lots of data especially in this era of ever expanding flash drives and various recording devices that grow continually smaller in size and ease of use increases. The difficult decisions come when attempting to “winnow” (Wolcott, 2001, p. 44) the data. With the ability to collect mountains of data, determining what to keep and what to discard could be an arduous task. MAXqda was the best choice to assist in my winnowing process.

After receiving all transcripts, I replaced the participants’ names with pseudonyms and saved the documents as rich text files (rtf) then imported rtfs into MAXqda. I began forming initial codes derived from clusters of meanings and highlighting quotes within the rich descriptions of the participants’ experiences. The memo function within the application allowed me to continually add my thoughts to the process. After reading and rereading my transcripts I added field notes then made additions and reflections in the proper areas. When each focus group session ended, the mediator and I would discuss comments made by the participants. These notes were also added to MAXqda. With every question asked in the interview, my thoughts were bracketed. Using MAXqda I reflected upon experiences and descriptions from the participants and was able to add my personal reflections directly to the document. All additions could be color coded and reviewed by designated themes and codes. I had ten codes originally, but was able to reduce them to four. Superfluous codes were eliminated.
The retrieval feature in MAXqda allowed me to quickly locate quotes in each transcript. Listening for what appeared to matter most for these female participants, I identified four major themes. As I looked back to my original questions, I found many instances where the data gathered were expected from previous research. However, unexpected outcomes were also part of my findings. Focusing on the words of my participants, I used in vivo statements as the theme titles that helped describe why the participants enrolled in the completion, what encouraged them to remain in the competition and what if any impact did informal STEM activities like the FIRST LEGO League contribute to the pursuit of additional STEM experiences in informal learning.

Validation

Validation strategies employed mainly fell to peer debriefing. At the end of each focus group, the mediator recapped what was discussed and allowed the participants to add or clarify statements. Very few participants added more detail. However, for one focus group in which a parent was involved, she was eager to discuss more in-depth observations. As the each focus group left the room, the mediator and I briefly discussed the high points of the group’s discussion, noting what we felt were oddities or comments that stood out. After all focus groups concluded, we reexamined my field notes making adjustments and reflexive points that we felt were important. After all transcripts were added to MAXqda my field notes were added and followed by the researcher’s memos. The mediator and I met again to review all additions in an attempt to view the data from another angle.

After I began analyzing my data, I met with two primary investigators involved with the grants that supported the robotics curriculum and the competition. We discussed
my qualitative findings and their quantitative findings. Though they found my data interesting, their data had not been completely compiled. When compared to data that is currently in press (Nugent, et al, in press), we share similar findings. Attitudes toward competition are positive. We are looking forward to more comparisons in the future along with publications from these data sets.

**Ethical Considerations**

Confidentiality was maintained by assigning each participant a pseudonym instead of using personal names. Each participant’s guardian signed an IRB informed consent form (Appendix C) and each participant signed an IRB assent form (Appendix D) that explained this research study and that any participant could drop out of the study at anytime without suffering consequences that may inhibit her competition. The mediator explained that all conversations in the focus group would remain in the focus group and would not be shared outside the focus group meeting. The mediator encouraged the participants to be candid and honest with any descriptions and stories they provided. The mediator explained the importance of not sharing what was said in the focus group with other girls at the competition. All recorded notes (digital and written) have been stored in a locked file cabinet in the researcher’s office and will be housed for two years. Notes are viewable by only the researcher and her advisor.

**Role of the Researcher**

With the need for growth in the STEM areas and the focus for graduating more scientists and engineers, we are on the path to enhancing programs that target the female population.
As many who choose to follow a qualitative research model, I have emotions that run deep for my topic being studied. I have been involved in technical fields for over nineteen years. I have been fortunate that I have experienced the cooperative nature of teaching technology skills and being the main “hardware” person, which meant all things from designing to installing networks, hardware and software troubleshooting, and all things server administration. In the school settings, where majority of teachers are women, most technical aspects were left to the men of the system. In technical meetings and serving on technical committees, I was often the sole female technical person. Early in my career I moved to a Midwestern state and discovered the cadres to which I belonged were no different from those in the south, all were very heavily populated by men. As I advanced in my career, fewer and fewer women were noted in my field. I was not the only one to take notice, therefore I was often ask to be a guest speaker at middle school career days, high school career day shadow programs, Expanding Your Horizon events (which is hosted by local universities to demonstrate possible careers for high school young ladies), and Science and Technology outreach programs (once again focusing on possible careers for high schoolers).

My passion for my career was the driving force for this research. I felt I was a very average child with a very normal childhood, yet why were there not more girls like me out there? Surely I was not the only one interested in how things worked and what made them run? As I began interviewing college aged women, I noticed very distinguishing characteristics that I shared with these other women. As children we all liked hands-on building. With me, it was erector sets, with this new generation it was Lego’s. We all shared a passion for “deconstructing” electronics in our homes. My
parents allowed me to take apart clocks and later electronic devices so I could see what made them run. I am sure they understood full well my inability to return each item to its original state. Though that aspect improved with time, allowing me to deconstruct items to satiate my curiosities was another trait that my parents shared with the parents of my participants. As the years progressed, I had fewer and fewer female friends; I had less in common with them. My personal interests and coursework proved to be a disconnect from female peers. It was only when I began college that I noticed an increase in my female friends. As noted by my previous research, my college participants noticed an increase in female friends since they were exposed to women who shared their same interests.

A clear pattern that was evolving between my participants and me was taking shape. The main difference involved our siblings. I have two sisters and two brothers, both sisters are in very technical fields. With my participants they are the only member of their families who are remotely involved in STEM fields. Statistically to have three females in one family in STEM related careers is an oddity, which is the case in my family. Traits I shared with my former research participants include hands-on techniques for learning styles, supportive parents, strong self-efficacy, positive self esteem and a passive aggressive competitive nature.

As discussed in other chapters, programs have been created that help to address the issues of low self-efficacy and low self-esteem in female adolescents. Former research has indicated that competitions only add stress to already stressful situations of female adolescents being singled out by desires to be part of more STEM like coursework. My role as a researcher is to help seek out methods that will not only engage
female adolescents in STEM coursework but to help discover methods that support learning while increasing self-efficacy, self-esteem and provide a cooperative competitive learning environment.

In my chosen career path, I continually see fewer women in my field, often times majority of my staff are male. Female colleagues usually have traveled a nonlinear path similar to mine. Even for the strongest willed adolescents, peer pressure years can be very difficult. Finding methods that allow any student male or female to pursue courses that are of interest in the STEM field are a must.

My interest in success stories of young women finding their way in a male dominated STEM world runs deeper than just helping girls engage in STEM coursework. My role in this research is both professional and personal. Ultimately, my goal is to help female adolescents have the courage and confidence to make choices that make them happy as relates to career choices. My sisters and I had the confidence to follow career paths that were not considered the norm. Only one sister followed a straight path to her aeronautical engineering career. My daughter turned six this year, my goal in life is to help her succeed, to help her gain the confidence to understand she can do anything she sets her mind to, of course hoping she follows in the footsteps of the women of our family.

Bias in not a word normally used in qualitative research (Creswell, 2008) however the researcher needs to be reflective while interpreting the findings. I realized my personal feelings must be put aside as I discovered, analyzed and illustrated the findings of those who have experienced this phenomenon of the robotics competition. In
my section on reflexivity, I will revisit my personal experiences and how they relate to this current study.
Chapter Four

Findings

Introduction

The purpose of this qualitative study was to describe the experiences of female adolescents in Nebraska who have competed in the First LEGO League and CEENBoT competitions. The aim of this descriptive qualitative study was to determine what influences participation of some girls in the Nebraska robotics competition via the 4-H robotics curriculum using non-formal teaching styles. The phenomenological analysis of four focus groups resulted in four themes.

Background of Robotics Program

The Nebraska 4-H, with grant funding from the NSF (Appendix K), has developed a program to increase science, technology, engineering and mathematics (STEM) achievement and interest using robotics and geospatial technologies. The program is based in part on the successful 4-H Robotics curriculum developed in collaboration with Carnegie Mellon University using the previous version of the LEGO Educational Robotics kit (Barker & Ansorge, 2007). The widespread availability of technologies such as the LEGO NXT Mindstorm robotics kit, handheld Global Positioning System (GPS) receivers, and geographical information systems (GIS) software like GoogleEarth and ArcMap make it possible for youth (ages 10 to 15) to explore and practice STEM concepts through the integration of these technologies. The original project is titled Nebraska 4-H Robotics and GPS/GIS in 4-H: Workforce Skills for the 21st Century (Appendix J), and is an intensive two-year program that begins with a 40-hour summer camp experience. The camp activities include the building and programming of robots,
working with handheld GPS receivers to explore and collect georeferenced information, and the development of GIS maps. Youth then receive additional 80-hours of hands-on robotics and GPS/GIS training during the school year in their afterschool programs or 4-H clubs. In year two, youth attend an advanced summer camp followed by 80 more hours of hands-on instruction during the school year. In total, participating youth receive at least 240 hours of focused hands-on experience over two years.

The long-term goal of the program is to improve STEM learning outcomes and attitudes of youth aged 10 to 15. Using robotics and GPS/GIS technologies focused on precision agriculture and natural resource management applications, the program seeks to develop and test a model of how STEM experiences delivered in the informal learning environment supports STEM learning and increases youths’ interest in STEM careers. The program educates youth on appealing applications of STEM concepts using an intensive robotics curriculum and direct information technology (IT) experience through a career exploration component of 4-H summer camps. Ultimately, the program is expected to: (a) promote youths’ interest in STEM fields (including IT), (b) introduce basic technology skills, (c) foster problem solving and inquiry skills, and (d) encourage teamwork – all leading to an increase in overall STEM knowledge and skills.

The curriculum includes building and programming robots using the LEGO Mindstorms NXT platform and is distributed in the form of kits. Each kit contains 431 components, including axles, gears, servo motors, and light, sound, ultrasonic, touch, and rotational sensors.

Camp activities are led by project staff and are organized by faculty. The content and context for the activities is delivered by short introductory lecture format followed by
hands-on activities supported by structured student worksheets. Youth work in pairs to complete the majority of robotics tasks, and small groups of three or four students are formed to complete certain more advanced robotics challenges. These groups of students form clubs, and meet on a regular basis to discuss, manipulate and problem solve activities with their robots. This principle follows the same structure as informal learning.

4-H Robotics and Geospatial Project is built on a 40-hour summer camp experience featuring hands-on activities that teach principles of robotics and geospatial technologies in promoting learning in science, technology, engineering, and mathematics. The summer camp is extended throughout the school year in forms of clubs that meet weekly not only to satisfy the needs of the curriculum, but to prepare themselves for the robotics competition that culminates from all activities learned in the club meetings.

Background of FIRST LEGO League Competition

FIRST (For Inspiration and Recognition of Science and Technology) was founded in 1998, by inventor Dean Kamen and the LEGO Group’s Kjeld Kirk Kristiansen. Together they created FIRST LEGO League (FLL), a powerful program that engages children in playful and meaningful learning while helping them discover the fun in science and technology. Over 140,000 children in 56 countries are currently active in FLL (www.firstlegoleague.org). Kamen and Kristiansen shared a belief that FLL inspires teams to research, build and experiment. Following this process ideas are created, problem solving is enhanced and the participants gain confidence in their ability to use technology.

FIRST provides four programs: FIRST Robotics Competition (FRC) and FIRST Tech Challenge (FTC) for 14 to 18 year-olds; FLL for 9 to 16 year-olds (9 to 14 in the
U.S. and Canada); Junior FIRST LEGO League (Jr.FLL) for 6 to 9 year-olds. FIRST also operates a research, development, and training facility called FIRST Place at its headquarters in New Hampshire, U.S. The FLL competition in this study involved 9 to 14 year olds. FLL is a global program created to get children excited about science and technology. FLL uses Challenges, ideas based on real world issues. Each Challenge has two parts: the project and the robot game. The project part of the Challenge for the competition in this study was entitled Smart Move and engaged students in critically thinking through processes of how things move; whether it be people and transportation or information. Each team had to analyze, research, and invent a solution to this real world problem. Each team had to present its findings and invention in a five minute presentation to a panel of judges. Many of my participants described this as the “presentation” or the “skit” where they presented or acted out their solution. In the robot game section of the challenge, each team had to build an autonomous robot that carried out a pre-designed mission in two minutes and thirty seconds. The project and robot game sections adhere to strict rules (Appendix L). The day’s events began with practice time for each time, allowing them three minutes to test the course. The teams could make adjustments as needed during the trial runs.

Overview of Participants

The focus groups totaled four with the number of participants totaling 27. All participants were enrolled in the Nebraska school system, with the exception of four students who were homeschooled. Grade levels ranged from 4th-10th and ages ranged from nine to fourteen. All participants for the most part were self-selected. Some participants were encouraged by coaches or team members. Due to the age of
participants, parents and participants signed consent (Appendix C) and assent forms (Appendix D). Several participants were turned away since they did not have a signed parental consent form. The event had over 300 students registered and some teams had numerous adults with them thus locating a particular person proved to be difficult if a signature was needed. I had enough willing participants that I did not need to wait for individuals to track down signatures, I easily moved to the next waiting participant.

Pseudonyms were assigned for all participants. Discussions were held openly without compromising integrity of participants or any circumstances during the competition or the events leading to the competition. I was surprised by the relative comfort level of these participants being in a room with strangers, not only the mediator and researcher but with other female adolescents they did not know.

As stated earlier, all participants were enrolled in the Nebraska school system except four who were homeschooled. The mothers of the homeschooled students were very adamant to be part of the focus group. I explained I was hoping the participants were going to be very honest with the answers they were to give and asked if they would be willing to do that with their mothers in the room. One participant said she did not want her mother there, but eventually conceded. It did not appear that it was a real issue, I noted in my field notes that it seemed more of a playful tease than a real concern.

Themes

The Strategic Air Command Museum entrance is a spacious area with glass ceilings that allows appreciation of the openness of the building’s foyer. On this particular morning on a brisk and chilly January, the unique foyer was barely noticeable. The entrance was crowded with students, parents, coaches and friends all taking part in the sign in process. There was excitement in the air, constant electricity; a steady buzz of conversations that eluded the growing anticipation as groups waited for the events to unfold. The crowds parted briefly as robots and various contraptions were carried in by other participants. All eyes would focus
on the incoming components but each cluster, distinguished by team shirts would quickly return to their animated exchanges. (Noted by researcher, 2010)

Table 3

*Major Themes and Quotes Supporting Themes*

<table>
<thead>
<tr>
<th>Major Themes</th>
<th>Quotes Supporting Themes</th>
</tr>
</thead>
<tbody>
<tr>
<td>It’s all about the competition</td>
<td>On competing against friends: Some ways I want to win, some ways I want to lose, but mostly I want to win.</td>
</tr>
<tr>
<td></td>
<td>On how the event felt: Culmination of hard work..high energy sporting event.</td>
</tr>
<tr>
<td></td>
<td>On challenges of the competition: There were always struggles, but it was not frightening, its challenging.</td>
</tr>
<tr>
<td></td>
<td>On choosing between other commitments and this competition: I only get to do this once a year, I can play basketball all season.</td>
</tr>
<tr>
<td>It’s like everyone is rootin’ for you</td>
<td>On teammates: Feeling of camaraderie within the teams and throughout the experiences of the competition.</td>
</tr>
<tr>
<td></td>
<td>On coaches: I could hear my coach over all the noise when we were competing. It was great.</td>
</tr>
<tr>
<td></td>
<td>On competitors: another team came over and said, “good luck” they even helped us fix our robot.</td>
</tr>
<tr>
<td></td>
<td>On validation: I have support from everyone who thinks I can do this.</td>
</tr>
<tr>
<td>What do I do with robotics</td>
<td>On careers: I want to do DaVinci stuff, not just Mona Lisa but water hydraulics.</td>
</tr>
<tr>
<td></td>
<td>On confidence: I want to work in the NICU…competition helped me learn to focus and not panic, we kept our cool and found a solution. Then jumped around later.</td>
</tr>
<tr>
<td></td>
<td>On ability: If I am good at this and figuring out why it didn’t work, I can do anything.</td>
</tr>
<tr>
<td></td>
<td>On uncertainty: I have no idea what I want to be, but I know I need to keep learning this technology stuff.</td>
</tr>
<tr>
<td>I know who I am</td>
<td>On self-image: I was called a nerd…I blew it off, I know what I am and this is fun for me.</td>
</tr>
<tr>
<td></td>
<td>On parental support: I told my mom I wanted to do this, but I did not know why…she agreed to sign me up.</td>
</tr>
<tr>
<td></td>
<td>On friends: This year I had more support than last.</td>
</tr>
<tr>
<td></td>
<td>On confidence: I plan on doing this again.</td>
</tr>
</tbody>
</table>
There were several common threads to all four focus groups. Some were expected but one was not. Every focus group singled out the competition as being a significant attraction to the robotics event. The majority of the participants in the focus groups were in their second year of robotics curriculum therefore making this their second time to compete with other teams. The irony about the competition is that it appears to be lacking the competitive component so many competitions are built upon. The male and female participants demonstrated similar beliefs; before an opposing team were to start a round in the competition, other teams would all wish them good luck.

The few in the focus groups that had not experienced the competition before admitted they did not know what to expect. They had not realized the robots needed to traverse various obstacles. They immediately began removing parts of the robot to ensure it would be able to maneuver strategically on the obstacle course. Others that watched offered suggestions to make the robots move easier, knowing full well they were assisting their competitors.

Findings like AAUW (2003) in its *Nebraska Girls and Technology Status Report* and Morris and Daniel (2008) stress the need to avoid competitions and to focus on collaborative styles to entice young women to the STEM fields. The director of the Boys and Girls Club of Omaha noted the competition was more about preparation and strategic thinking than a true sport competition. Williams (2007) claims boys socialize to compete whereas girls socialize to collaborate. If Williams and the director of the Omaha Boys and Girls club are correct the findings in this data may have come out dramatically different. Perhaps due to the collaborative nature of the competition, it has more allure to those who might not normally prefer competitive situations. Or this curriculum with its
informal learning situations provides the needed foundation that allows each individual to feel confident while competing.

All themes were in vivo, the ones that stood out were *It’s all about the competition, It’s like everyone is rootin’ for you, What do you do with robotics, and I know who I am*. The first theme is self explanatory. The competition was clearly a big draw for these participants. It was noted by others when observing other teams in the competition they had their eye on the prize of winning. The competition and the expectation of winning for those in my focus groups were more subtle.

The second theme *It’s like everyone is rootin’ for you* describes the feeling of camaraderie within the teams and throughout the experiences of the competition. As mentioned earlier, some teams were cockier in their expectations of their personal performance as noted by other observers and I doubt they offered the support that was mentioned by my focus group participants. My focus group participants were not exposed to these particular teams who held the cutthroat, win attitude.

The third theme *What do you do with robotics?* focuses on the futures of the participants. The older student participants had put much thought to their career path. This was evident by comments made regarding various teachers who have significantly influenced their thought process. These participants talked of possible careers and courses they might like to try either in high school or in college. They have a broader picture of what are career possibilities.

*I know who I am* is the fourth and final theme. Both younger and older participants from my focus groups were there for fun. However the older participants revealed mild tribulations they encountered within their schools concerning courses or
previous competitions in which they were involved. Though these issues seemed rather mild, it still implies that girls who don’t have a strong will or mindset to follow what makes them happy might miss out on STEM related coursework due to negative connotations.

**It’s all about the Competition**

“The culmination of all that hard work for many teams is the participation in an FLL event – much like a high energy sporting event” (Kamen, 2010). The participants in this study shared the same phenomenon of learning situations and competitive scenarios. The learning situations revolved around respectful group learning and sharing but always with a hint of competition even in the classroom setting. The participants learned not only to program their robots, but design, build and test the inputted programs on a course that simulated the actual platform the robots would negotiate at the competition.

Each team met weekly to learn new skills on design, building, and programming through a curriculum designed by Nebraska 4H and Carnegie Mellon. Though the FIRST instructs usage on robots for the competition, the FLL site lists the Nebraska 4H curricula, GEAR-TECH-21, as a very comprehensive curriculum for teams to expand their knowledge including additional modules to keep youth engaged in STEM year-round.

Every focus group member at some point mentioned the competition and the excitement it brought with it. Some members were originally there because they liked being with their friends but somewhere along the way they were hooked. Every participant in their second year of the competition was there solely because she wanted to be, often citing the competition as the main reason. Sarah’s comment was a common
thought for many who were there with friends, “Um, in some ways I want to win, in some ways I want to lose but mostly I want to win” (Sarah, participant).

There was much discussion that revolved around the competition. Throughout the after school programs the previous year’s competition attendees, would make comments regarding the competition. Sadie (participant) remembers the boys in the afterschool programs making comments like, “in last year’s competition, it was so cool when. . . .” and “do you remember when we . . . in the competition?” Several focus group participants said comments such as these really made them “work harder” on their robots. They wanted to be part of the competition and felt they had a chance of winning. “I’m good at this! I’m like better at this, figuring out how you are supposed to um, how you get the robot programmed,” (Margaret, participant). Most of the participants honestly felt they were good enough to succeed in the competition. “I am really excited because this is different from what I normally do and I did really good today,” (Shannon, participant). “What do I think about the competition? it’s the best part!” (Michelle, participant).

“There are always struggles, but it’s not frightening, its challenging,” (Daisy, participant). “Last year the competition was at the boys and girls club and it was fun, so um I wanted to try being in the competition so I tried for robotics,” (Mary Anne, participant).

Not all participants were eager to program their robots. “I like building the robot better, it’s easier. I mean I always had LEGOcs at home and was always making these cities and stuff. I’d get confused programming,” (Dani, participant). Others thought it was difficult but made it work. “Something that was really challenging for me was to uh, well, the lego robotics is something challenging for me was to know how to uh, get the robot
programmed and started to make it go in the right direction and pick up the little square things,″ (Mary Anne, participant).

The competition forced brothers to compete against sisters, cousins against cousins and friends competing directly against friends. None of the oppositions were malicious in any way. The focus group participants were active in other after-school activities. Extracurricular activities included: soccer, volleyball, basketball, track and swimming, “I had a swim meet today. I told my coach I wanted to be here, he said he understood. I know I should have been with my team but my time is very limited for the robotics competition” (Jeri, participant).

Jeri told me her time at the competition was very limited, she was a sophomore and this was her last year to compete. She can swim competitively all through high school. If her coach truly understood, which I am inclined to believe, I think it demonstrates the vast understanding that most instructors and teachers have for exposing any students to STEM related activities. I am not certain if this swim coach was encouraging or pushing Jeri to participate in other STEM related activities but his actions speak volumes for understanding the need for exposure.

Jeri was not the only participant who chose the robotics over another event. Last year’s competition fell on the same Saturday as a volleyball tournament for one student. The participant said she chose robotics over volleyball, but then later remembered she was able to do both due to staggered times of the two events. Several participants said they would choose the robotics competition for several reasons, including limited window of opportunity to participate in the robotics competition (due to age) and it reinforces math and science skills (Julie, participant) they may need in the future. “I think
it will help me in my more difficult subjects…in subjects I don’t do very well in. This [the competition] helps me think differently,” (Jean, participant). “[I would choose the competition] because, I only get to do this once a year and basketball I have a whole season,” (Julie, participant).

**Parental voice.** A parent whose children were homeschooled shared her frustration with the age limit, “[My son] turned fifteen this year so he is out. A couple of good kids are out next year because of the rules.”

**It’s like Everyone’s Rootin’ for You**

“Our competitions encourage coopertition” (Kamen, 2010). “Cooperition” and “gracious professionalism” are trademarked words developed by Dr. Woodie Flowers, FIRST National Advisor and Pappalardo Professor Emeritus of Mechanical Engineering, Massachusetts Institute of Technology. Gracious professionalism demonstrates doing things that encourages high-quality work, emphasizes the value of others, and respects individuals and the community. Cooperatition is defined as displaying respect in the face of fierce competition. It is grounded in the philosophy that teams should help and cooperate with each other throughout the competition. It is founded on the concept and a philosophy that teams can and should help and cooperate with each other even as they compete. Coopertition is learning and teaching teammates, it is competing while assisting. The participants were students and mentors in this program; they experienced support from their families, but support from fellow competitors. In turn, they offered support to others in the competition.

Participants not only spoke of parental support for the previous year’s curriculum from their parents, but it was very visible at the competition. The number of adults that
were present was a very visible measure of support. Most adults who were there to support their son or daughter were sporting vivid colored shirts with team lettering. Many of the participants of my focus group had extended family members in attendance. Teachers who were not directly involved with the competition were there offering support to their students, “I could hear my coach over all the noise when we were competing. That was great” (Jennifer, participant).

The support was not limited to the adults but to other competitors. The first year competitors were very shocked at the reaction of other teams and how encouraging they were, “When we were practicing for our time to go in the competition and another team came over and said, ‘good luck,’ I was like wow!” (Sue, participant). This was a very common occurrence. Comments about being “good enough” and “knowing how to fix the robots to run the best” (Ricki, participant) was made intensely clear all participants were there to win, the camaraderie and compassion was very evident. “We’re working as a team and having support from everyone who thinks I can do this,” (Paula, participant). Compassion seemed to bleed into other aspects of competitors lives, “My brother and I normally don’t get along, but we both like this and help each other. But I still want to beat him,” (Beth, participant). Another comment regarding a brother and sister team and how she felt regarding the competition, “this would be more enhancing in my learning for robots because me and my brother we are always building stuff. So I figured this might help out a little bit with that,” (Ashley, participant).

Participants were given a limited amount of time to practice before the timed trials. It could be a very frustrating time, but advice and help was often offered by other
teams. This type of uncontrived assistance might to be attributed to the learning environment set forth by the curriculum itself.

Not all students felt support from parents. Cindy (participant) commented, “I want to be a vet but my mom said I would not be able to.” Cindy was homeschooled participant whose mother was present and added, “I think I said you have to study really, really hard and it’s very competitive, more than medical school.”

**What do you do with Robotics?**

"To transform our culture by creating a world where science and technology are celebrated and where young people dream of becoming science and technology leaders” (Kamen, 2010). The older participants demonstrated they had guidance when thinking of careers and future studies. Science teachers were credited with focusing the hardest with the older female participants. The younger female participants declared teaching careers or dental hygienists. It was apparent the younger participants had not realized they were focusing on science, technology, engineering and mathematics when working with the robotics curriculum. The curriculum and the FIRST program are designed to create an atmosphere where students are engaged in STEM related activities while encouraging students to pursue careers in science, technology, engineering and mathematics.

When questioned about possible careers or what the participants were going to do in the future, it was evident the older participants had already placed a great of thought on this topic.

I want to major in art kind of like Da Vinci did and like use it for different things and not just Mona Lisa art stuff like he has the water and hydraulics stuff, to use it you have to know how to work it. ( Jamie, participant)
There were several who mentioned becoming teachers, but those were mainly the younger participants. One participant talked about being a nurse in the NICU, and how the skill set she learned throughout the coursework and specifically the competition would help her to remain calm in times of adversity. She added the curriculum gave her the confidence to come up with a solution.

Well, I want to work in the NICU so it’ll probably help with all the technology. It helps that we really need to focus to come up with a solution and not panic cuz we only get two minutes to figure it out. We keep our cool then jump up and down later. (Tara, participant)

Many older participants described classroom discussions mainly with science teachers that provoked thought for possible careers. One participant mentioned she had no idea what she wanted to do, but heard that many jobs that will be available in the future have not been created yet, “I just need to keep on learning technology stuff. It’s all around us and will only get bigger” (Brittany, participant).

When the younger participants were asked about their future plans, the answers demonstrated they had not put much thought into the matter often citing teaching as their career of choice. “Um like I said a teacher and whatever I become and just end up to be I guess,” (Haley, participant). On the other hand, the older participants had been thinking of careers. These individuals mentioned specifically science teachers who were openly discussing potential career paths. “We spend soooooo much time talking about careers. I like it when my teachers shows me. Like some of the careers were film producers, special effects people, veterinarians that work for NASA. That was the coolest.” (Anna, participant). The older participants had concrete ideas about their futures and knew the skills attained in the robotics afterschool programs would help them achieve their goals.
“If I’m good at this [robotics] and figuring out why it didn’t work, I can do anything,” (Debbie, participant). These participants appeared to look to these teachers as role models, which was an expected outcome.

Some participants transferred from other states that had similar programs and sought out this 4-H curriculum. The curricula from other programs are similar in design and structure. The participants who joined from other locations were not disappointed when they joined this group, citing similar experiences with exciting familiarity. The focus of learning together (collaboration) and the hands-on experiences were the original draw to other programs like this curriculum and competition.

**Parental voice.** I was fortunate to have several very unwavering mothers who wanted to be part of the focus groups. It was not my original intent to have parents part of the focus groups, but these particular moms were not going to let their daughters proceed without them. I had already dismissed the other potential participants, so I decided to allow them to stay. Since they were willing participants I took advantage of the opportunity to have them share any observations regarding their daughter’s participation and experiences within the curriculum and competition.

Some mothers wore many hats on competition day. They served as both coach and supportive mom. Another I met was mother, coach and a director of a local kid’s club. This happenstance provided valuable information. A mother of a homeschooled participant stated she felt they were at a disadvantage since she had so much information to learn before they could get started, but added “next year will be easier.” I think this is positive reinforcement that they are not giving up and will persevere even when they have struggled because they see value in the program. This mother stated her children
were the first generation of their family to be exposed to STEM careers and attributes this introduction to the robotics curriculum. Not all mothers of homeschooled participants shared her enthusiasm. “This was very difficult, and time consuming, not to mention all the days we had to rearrange meeting times due to weather, I’m not sure we will do this again,” (Mother of homeschooled participant). The competition brings a diverse number of individuals together who have similar interests, something homeschooled children may not experience as much as those in a larger school district.

One mother’s reaction to my questioning her daughter on a prospective career:

It’s exciting just to expose them but quite honestly, I feel like I don’t even know sometimes how to even direct that exposure um because I, I, you know when you were asking about what kind of field they would go into and everything, I wouldn’t even know what to tell her. What do you do with robotics? You know I, I’d have to sit and think and use that to guide a little more. Because I think, I think they would be interested in [STEM fields] very much so. (Sylvia’s mother, homeschooled participant)

I found Sylvia’s mother’s comment very interesting especially when I was informed Sylvia’s father was a programmer. The only connection they made to STEM fields was programming, none of the other careers options were acknowledged.

Pamela’s mother was very agitated at leaving Pamela at the focus group’s door. Pamela’s father kept coaxing her mother to let her stay with me and the focus group. Pamela’s father was very encouraging, “Go, it will be fun! I will be right around the corner.” Pamela began walking in but her mother was close on her heels. I finally conceded and allowed her to stay. I had previously allowed homeschooled parents to remain in the room and thought this might also provide important data to my research. This proved very true. Pamela entered the room and sat close to the door. Her mother was not far away. As I began to introduce myself and the mediator, I explained that I wanted
honest and open answers and acknowledged a parent in the room ensuring all comments were to be confidential. Everyone agreed. As the questions began this focus group fell in line with the others. In a recap session, the mediator noted, “it’s like they just exploded with all this vocabulary and answered questions as if they were surrounded by friends.” She also added, “I would have never done [been so comfortable] in front of so many strangers at that age.”

As participants began to answer and respond to each other’s comments, Pamela’s mother was amazed. Pamela was a chatty, insightful young girl who had much to share. Perhaps it was because her mother was standing out of her line of sight, but I did not notice any hesitation with Pamela’s willingness to participate. Pamela’s mother was a co-coach on her team.

Speaking on the mom’s side of it seeing the change in my daughter I was very surprised. It’s not something that I thought she would have done. Then to sit back and watch her taking charge and almost being bossy at some points, telling people what to do and how to do it. Something that maybe she needs to work on but I was really impressed and I was happy to see her do that and take an interest in it. Now that she’s done it I’m happy to say that she seems like she wants to do it again. (Pamela’s mom, participant)

Pamela’s mom told me later that she is a quiet child, “not that you could tell that today.” This has opened her mother’s eyes to see her daughter’s potential, understand what it means to be interested in the STEM fields and to help her daughter seek professions that could build on these experiences.

I know Who I Am

“It makes you feel if you try hard enough, you can do anything” (FIRST team member, 2010). Being singled out is never easy, it is most difficult in the adolescent years. The robotics curriculum and competition permitted these female adolescents to be
surrounded by others who share the similar interests. Though majority of these girls exhibited a disposition of strong self-confidence, the structure of the robotics curriculum and competition allowed all team members to feel valued.

Several participants recalled comments made by others in their junior high and high school classes. “You’re being such a nerd” and “You really need to do something fun” were common commentaries. “Um one of my friends and some of my family call me nerd. Although my dad is in the engineering business,” (Sue, participant). Another participant shared, “I was called a nerd by classmates.” When asked how she felt about that, she responded, “Well, I just blew it off I’m like ok I know what I am and this is fun for me.”

Negative comments made by others stung and female adolescents who had a less secure self image might have let these comments sway their decisions to enroll in these courses. When one participant brought home literature for the robotics program she was asked why she would want to be part of such a geeky thing. “I don’t know,” (Samantha, participant). Samantha replied she did not know, and from her comments I derived she truly did not know, she did express that she knew it was something she wanted to do. “I don’t know I just saw it and the photos of what they were doing and I wanted to do it too,” (Samantha, participant).

Several participants noted the idea of them competing or even joining the robotics classes were not frowned so heavily upon. “I felt more support [from friends] this year than last year,” (Julie, participant). The participants of the focus groups seemed very at ease with themselves and at ease with others in the room, even though they did not know others in the room.
**Parental voice.** A parent who was co-coaching a team said the team was fairly large. On average more boys dropped out of the program than girls on her team. She noted the girls seemed more committed to the program than the boys.

One mother explained as she was signing up her son for the robotics curriculum was asked if she was signing up her daughter as well. The mother’s response was, “Heavens no, why would my daughter want to be part of this?” When this mother actually asked her daughter, she was very surprised by the excitement displayed by the daughter to be part of the curriculum and the competition. This same mother described a situation with a counselor in college, “I wanted to take programming but my counselor asked if I was sure since the course was so tricky.” She did not take the course. The experience was very vivid in her mind, yet she nearly perpetuated a similar circumstance with her daughter.

**Researcher’s Reflexivity**

I was one of the women who took the path of “multiplicity.” I did not travel the normal route to the technical positions I have held or that I currently hold. Like the participants in my focus groups, I also participated in extracurricular activities, especially sports. I never thought of myself as a competitive person, I liked working in groups; I liked being part of a team. However when it came right down to it, if there was a first place, I wanted it. My goal has always been to help others succeed but in the process I always strived to do my best.

As I reflect on the themes and participants statements, I see many commonalities though there are generational differences. The first in vivo theme, *It’s all about the competition*, was the main theme in which I did not totally relate. I was competitive but
did not live for the competition. I felt more akin to my participants who were more reticent to show their competitive skills. These very participants quickly fell into the spirit of the competition once the sessions were underway. I had a competitive streak but saved it mainly for sports, my participants carried this emotion throughout every event they encountered. My sport of passion was volleyball. I attempted softball but soon discovered I felt too isolated even though I was part of the team. A comment that resonated from most participants in this study was they enjoyed working with others but they did not mind being singled out for competition purposes.

The second theme, *It’s like everyone is rootin’ for you*, was a very common feel for me. I had support from teachers, counselors, my parents and siblings. It did feel as though everyone was on my side. Though I did not have the experience of the competition during those years, my inquiries into Science, Technology, Engineering and Mathematics were always supported. Teachers supported me through praising my accomplishments, not the fact that I was smart. Counselors supported me by the constant reminders of what academies and universities would offer the best school experiences for my college years. My parents continually encouraged my personal growth and continual learning. They supported all endeavors that I attempted from disassembled electronic devices to experiments gone awry from my chemistry set. My parents reassured me and my siblings that all things are possible. With this as our model, we demonstrated the same support to all siblings.

Theme three, *What do you do with robotics*, held similar struggles for me, but in a different flavor. I knew I liked “tinkering” with things and fascinated by how they worked, but never made the connection that I could make a career out of it. I loved
computers, but some of the same connotations of the lonely programmer sitting in a cubical were even stronger then as opposed to now. Back then, it was a reality. I remember my high school counselor did not know what to suggest supporting my career preferences. She ultimately suggested West Point Academy. I did not feel the academy was my personal calling.

Most teachers are very cognizant of the need to expose students to various career paths. This was once again made very clear to me during a recent extracurricular event my daughter experiences. The course was for kindergarteners and was themed animal adventures. After a week of instruction and activities the class discussed careers that involved working with animals. These careers ranged from veterinarians to scientists working on very specialized projects.

The last theme, *I know who I am*, resonates most clearly for me and for the women I have worked with in the STEM fields in the past ten years of my career. During my high school years, I was an overachiever, but these standards were to please me, not others. I did not have many female friends; I did not feel I need to be involved in their day to day dramas. I was happy with who I was and the direction I was headed. Though hindsight I had no idea where I was headed but was confident I would arrive ahead of the game. Some participants of this study endured negative comments from peers or siblings in regard to the curriculum and competition. The jeers have subsided considerable since my first pilot project involving college aged women several years ago, who dealt with unending comments from peers and classmates. I vaguely remember comments through the years about being nerdy or geeky, but it was my demeanor to laugh at them, I never felt nerdy nor did I feel I looked the part.
The college students from my previous pilot project (Notter, 2007) noted they did not have many female friends until they entered college or were exposed to extracurricular events such as Women in Science or Expanding Your Horizons. I too had a similar experience although I did not meet other women that shared the same interests until I entered college. The girls involved in the robotics curriculum and competition, did not share a similar experience. They had girl friends that were taking classes and competing with them. I have discovered through conversations with staff members, especially those closer to my age, they have engaged in similar paths of finding female friendships only after they are established in their fields.

I have been asked to serve on many committees and panels regarding interventions to involve more young women in the STEM fields. In one such panel, I remember being asked a rather personal question regarding my career and its effect on my personal life. The mediator immediately interjected that I did not have to answer the question. I chuckled and answered. I feel very strongly that it is imperative questions such as these (and others) are answered openly and honestly. Female adolescents need to have answers to their personal questions in order to make sound judgments regarding their futures. In order to make sound decisions we must surround ourselves with the facts.

Summary of Findings

Overall the findings reinforced what has already been discussed in prior research. The most significant finding is the excitement for the competition, which most research has stated girls do not like competitive situations. The young women in this study enjoyed the competition, which is in direct opposition to what has been presented previously. Gürer and Camp’s (2001) *Investigating the Incredible Shrinking Pipeline for*
Women in Computer Science states intense competition only decreases already low levels of self-esteem in women. The comments made by these participants indicate they did not have low levels of self-esteem. Perhaps the competition did not have the feel of intenseness due to the collaborative nature of the teamwork.

In the grand scheme of things, these participants were average female adolescents. The younger participants were giddy and silly, while the older participants were more controlled and their answers were more thought out. When they discussed conversations they had within the groups or clubs, they would often giggle at the details of their dialogue, noting their conversations were about the solder needed on this piece or that then the conversation would turn to boys. The female participants in this research view themselves as average girls, who are very comfortable with themselves. Statements like “I know who I am” and “I am comfortable in my own skin” are very clear examples of their personal views.

Theme One: It’s all about the competition. Previous research has demonstrated that collaboration without competition is the best method for teaching female adolescents (Sanders, 2006; Funk, 2003; Morris, 2008). From the voices of my participants this research does not hold true with my participants. Each participant enjoyed the competition itself. The learning environment was not as competitive as the final competition. Within the robotic curriculum, each participant had to program their robots to traverse various courses. Some used trial and error but most strategized to find solutions. This work was performed in groups, working collaboratively. The findings of this research demonstrate that collaboration with competition is a good fit.
Theme Two: *It's like everyone’s rootin’ for you.* Prior research demonstrated good role models (Nicholls, 2007; Bart, 2000; Quimby & DeSantis, 2006) are an important factor for adolescent success rates in STEM courses or career choices. Parental support is also key (Lee, 2003; Brotman & Moore, 2007; Jacobs & Eccles, 2000). When the focus group participants were asked who their biggest supporters were, all participants mentioned their parents and several mentioned science and math teachers. Some teachers were present just to show support, they were not involved in the competition as coaches or sponsors. When the participants spoke of these teachers it was with admiration and respect.

Theme Three: *What do you do with robotics?* With the ever-growing need to graduate more scientists and engineers, the negative connotations of these careers must be eliminated. In prior research when adolescents are asked to describe a scientist, a lonely individual is depicted in a laboratory devoid of other personnel. A person seeking a computer science degree usually carries negative associations (Sanders, 2006; Lee, 2003). Role models are often associated with professionals in the STEM fields who make themselves available to students demonstrating a multitude of career options. When discussing career choices or what the participants would like to do in the future, considerable differences were apparent for the participants of the focus groups. The majority of the younger participants named teaching as a profession of choice while the seventh graders and above mentioned professions varying from artists, special effects designers, to specialized medical fields. The participants that were homeschooled had not given much thought to this idea. One homeschooled participant said she did not want to
be a programmer like her dad so she was not sure what else she could do with her robotics knowledge.

Theme Four: I know who I am The participants of the focus groups were aged 10-16. Their demeanor was surprisingly calm; they were excited to be at the competition but relaxed during our session. Each participant seemed at ease in the focus group, even though the room held not only strangers but their competitors. My field notes reminded me of how they quietly entered the room, how they perched in their chairs and how after the introduction phase, they leaned back in their chairs as if conversing with old pals. Prior research suggests peer pressure (Jenson, de Castell, & Bryson, 2003; Williams, 2007) is a major factor for most female adolescents when attempting to do something other than the accepted norm, in this case enrolling in a robotics curriculum. Though some female participants heard derogatory comments about wanting to participate in the competition and curriculum, they signed up anyway. These participants were eager to compete and eager to win. Each participant had a healthy expectation that winning was a reality.

These findings indicate the participants are not only comfortable with robotics curriculum but they are building critical thinking and problem solving skills, demonstrating flexibility and adaptability while fostering communication and collaboration, all of which are skills needed in the workplace.

In the study by Nugent, Barker, Grandgenett, and Adamchuk (in press), impacts of robotics and geospatial technologies interventions were tested on middle school youth’s attitudes and cognitive skills as related to STEM. The two interventions tested
were a 40-hour intensive robotics/GPS/GIS summer camp and a 3-hour event modeled after the camp experience.

The results showed significant increases in cognitive pre and post tests for the long term intervention group. Significance was noted in both boys and girls. Self-efficacy also demonstrated a significant increase. Self-efficacy, a student’s perceptions of their abilities (Bandura, 1997), can influence the level of engagement in STEM learning (National Research Council, 2007). The robotics intervention revealed increased self-efficacy. Robotics has shown to assist in the transformation of abstract mathematics and science concepts to real-world applications, therefore promoting increased positive expectations of success in mathematics and science.

A similar study attempting to determine long term effects of robotics programs (Weinberg et al., 2007) followed students through a year long process. Both quantitative and qualitative methods were used. The quantitative numbers demonstrated the young women in the study increased positive attitudes toward engineering and with mixed gendered groups had increased self-concepts. However the all girl teams experienced little change in self-concept regardless of mentor effectiveness. A very interesting finding in this study stated the girls would rather program the robots than build them, they felt programming was easier. This is the opposite finding for the data I collected from the focus groups.

With research indicating early interest in STEM as a predictor for possible career interests (DeBacker & Nelson, 1999) and robotics as a means to engage young women in STEM activities, it is possible for female adolescents who choose to join a robotics
course show potential to seek out other STEM coursework therefore leading to possible STEM career pathways.

First Lego League (FLL) was the culminating competition in which I collected data. This competition was funded through a NSF grant (Appendix I). The Brandeis University Study prepared by Melchior, Cohen, Cutter, and Leavitt (2005) discovered the First Lego League alumni significantly outperformed the matched comparison group in a longitudinal study. The majority of participants in this study were males who had B+ averages before attending the First Lego League competition. The general information that was discovered still proves that the competition itself does not hinder personal success, in fact may prove just the opposite. As noted in Figure 1, FLL alumni demonstrate all areas studied significantly show FLL alumni reaching a fuller potential.

![Figure 1](http://www.usfirst.org/aboutus/content.aspx?id=46)

*Figure 1. Impact: First robotics competition evaluation.*
The essence of this study is the empowerment of these female adolescents through the positive experience of the competition as it coexists with the robotics curriculum. The combined shared experience of the competition was excitement, energy, and the desire to have this experience over and over again. Along with the excitement of competition, importance of support of peers, parents and teachers were very evident. Validation of being a part of something they love and more confidence to pursue other STEM courses/curricula were lifted up from the shared experiences of these female adolescents.
Each participant described the competitive nature of the curriculum and the actual competition. They detailed the cooperative environment in which instruction took place and how cooperative competition enabled them to be more motivated with the robotics curriculum. The competition is a high energy sporting event that encourages coopertition, which is respecting all who compete in the face of fierce competition. Coopertition is a core value of the FLL program and is thought to encourage innovation and success through competitive and collaborative learning situations. The paradoxical commonality was the cooperative competitiveness. The structure of the learning environment was favored by all the young women in this study. The giddy nature of these girls as they described the feeling of winning the most points at the competition was uplifting. Reliving the experience in the focus group, I was able to watch the emotions that displayed their enthusiasm for being part of the event. Even as those explained their shortcomings in the challenge portion, they beamed when describing their supporters (parents, teachers, and coaches).

These young women have put considerable thought into what their futures hold for them from specialized medicine to engineer designers who look to Da Vinci as role models. These young women are confident and engaged in the competition. The non-formal learning structure of the classroom environments that led these young women to this competition, allowed for mistakes to be made in a safe environment while getting the needed support from teachers and classmates. It did not matter that the young men out numbered the young women in their local settings; the competition allowed these girls to mingle with other female adolescents that share similar interests.
Chapter Five

Conclusions and Outcomes

Introduction

The purpose of this study was to describe the experiences of young women who have competed in the First LEGO League and CEENBoT competitions. Other studies have been conducted that have attempted to determine the attrition rates of young women from STEM programs. The aim of this research was to present the other side, to speak directly to female adolescents who were involved in the STEM coursework and were participating in the competition. The findings of this qualitative study add to the knowledge of why female adolescents want to be involved in robotic competitions. With the insights from this research, I hope the voices from the participants will relay what is needed from parents, educators and mentors that will encourage female adolescents to pursue careers or coursework of their choice.

Discussion of Findings

The focus group questions (Appendix F) revealed much about the participants of the focus group and why they were part of the competition. There has been much data discussing reasons why female adolescents choose to stay away from STEM related coursework. Computer courses or technology courses have been thought to be masculine (Brunner & Bennett, 2002; Margolis & Fisher, 2002; Nicolosi, 2002) and should be avoided for this perceived negative connotation. Other research suggests the lack of role models (AAUW, 2004; Bart, 2000; Lee, 2003; Messersmith et al., 2008; Nicholls, 2007) add to the decline in young women taking courses in the STEM fields. Parental support
as stated by Jacobs and Eccles (2000) and Messersmith et al. (2008) provides profound unintentional influences.

With all these factors in play, the young women for this competition not only completed the robotics coursework for the year (some have been involved for two years) but they were highly successful at the competition. The factors listed above which have been considered by previous researchers as obstacles did not hold back the female participants in this competition.

In my discussion of my research findings I have listed my research questions and the answers derived from my focus groups, sample transcripts are located in Appendix G.

1. What are the factors that encouraged participants to participate in the robotics competition?

The most prominent factor that encouraged female adolescents to participate in the robotics competition was the competition itself. Comments from former FLL and CEENBoT competitors through the course of the yearlong curriculum built excitement for the year end competition. The camaraderie that was displayed on the competition floor was evident and for the most part contagious. It was stated that all the “small pieces” contributed to the excitement of the pending competition.

The participants chatted about the afterschool sessions, the feeling of successes during the coursework and understanding that all the hard work that went into building and programming their robots would pay off at the competition. These participants felt good about what they accomplished in the
after school informal learning sessions. They had confidence in their abilities and the extent of their problem solving techniques. They did not wait for instructions when they were troubleshooting, but using hands-on techniques they proactively moved from one troubleshooting technique to the next until a resolution had been found.

2. What was the original enticement to the FLL and CEENBoT programs?

Many of the participants in my focus groups first became part of the programs because a friend convinced them to join. A few were the instigators that asked their friends to join with them. The girls who wanted to join did so even if their friends refused to be part of the program or dropped out after a short period of time. Those who are strongly interested in robotics, science, math or other technology extracurricular activities usually join without giving serious thought to negative consequences from other friends. As demonstrated earlier in my findings, these young women have confidence levels that allow them to make choices that may not appear to be mainstream. Being popular never appeared to be an issue with the girls in my focus groups, they made choices that made them happy.

For various reasons, several girls had left previous schools or school districts. If they had participated in a program that was similar to the FLL and CEENBoT programs they searched for similar programs and joined immediately.

3. What will make participants want to come back and what are the participants’ plans for the future?
The reasons cited by participants for coming back to the competition next year varied greatly between the homeschooled students and the traditional students. The homeschooled students were very intrigued by the gifts/trinkets they received from the vendors. The traditional students, while enjoying the gifts and trinkets were not that impressed. The homeschooled students mentioned several times they liked the markers, bracelets, notepads, pencils and the food that was available. The traditional students were excited about the competition itself, seeing how they measured up to others competing. They were very in tune with their points scored and where they stood in the competition’s final assessments.

The homeschooled students were more focused on performing the skit. The skit was the presentation portion of the competition. I attributed both the “free stuff” obsession and the “performing” for the homeschooled students to the lack of events or ability to socialize with large groups of students during their regular school year.

The homeschooled students by parents’ admission were lacking the ability to connect careers to the events or skills learned during the competition and prerequisite coursework, even though one father of a homeschooled student was a programmer. A major association the homeschooled students made were to only programming careers.

The traditional younger students also were lacking in the ability to tie science, math or technology to professional aspirations. The older students, however, with the encouragement of teachers often discussed potential
occupations spanning from art to dance (both using technology), filmology, medical positions to jobs that have yet to be created. These female adolescents were comfortable with not having a plan; knowing they will continue with their fascination of STEM coursework they felt assured they would work in a field that would not only provide a satisfactory income but allow them to contribute in some way to society.

Both groups stated they will continue to seek out STEM related coursework and programs. The mothers of the homeschooled students said they would intentionally search for programs and clubs that allow their daughters to pursue STEM fields. The traditional students said they would persist in this program and look forward to next year’s competition. If they had cared what classmates thought of joining in these afterschool activities, they no longer did.

All participants agreed they liked the hands-on method of learning with the robots. “It was fun to play with the robots” was a common thread. It was evident they all wanted more time with the robots.

**Significance**

Previous research has determined that competition is not the way to entice young women into the STEM fields. The conversations with the participants in this researcher’s focus groups lead to other conclusions. As Taylor (2006) noted about female gaming strategies, the aspect of collaboration, coupled with competition appeals to young girls. The data examined in this competition echoes these findings.
It is important we increase the number of graduates in the STEM fields. Competition may actually be a way to increase the number of young women into STEM Fields, the notion of competition needs to be readdressed. Whether it is the teamwork approach that is enticing, or the competition itself, as a society we need to make a cultural change. Earlier research states we need role models, mentors, and possible higher self-efficacy for female adolescents to thrive in STEM environments. The research data collected suggests the robotics curriculum and FLL competition provides rich environments which fulfill the conditions needed for successful STEM interventions for female adolescents. The conditions include providing needed role models through this curriculum, especially if the instructors are women. The learning environment lends itself to a collaborative design whereby the teams work competitively while working cooperatively.

**Limitations of the Dataset**

Limitations of the data set included restricted sample size and time constraints for the focus groups. The focus groups met after competitions were completing. Several potential participants/coaches stopped by to check the schedule to see when they would be able to participate. Due to the staggered schedules of the competition, not everyone who wanted to be part of the focus groups was allowed to take part.

The participants of the focus groups that were conducted the day of the competition may not have been “average” female adolescents. The group that had participated in the competition may have high self-esteem and high self-efficacy and therefore not bothered by the impediments that were thought to hinder success in STEM coursework. They may have not been fazed by wanting to take courses that may have
been considered masculine or nerdy. This group may have been very comfortable with who they are and may not seek approval of others. Not succumbing to peer pressure at this age is unusual. There is no guarantee their views and experiences are typical.

The numbers of parents that were on site the day of the competition was a tribute to the support that these participants have been given. Most of these families by the time of the competition are heavily invested in the process that led to the competition. Though I feel these findings would replicate in similar audiences, the data acquired in this study may not be transferable to a much larger population.

**Future Research**

Perhaps it is the nature of the structure of this competition that makes it more appealing to not only young women but to young men also. The teaching methods in place that leads to the competition are not indigenous to this robotics curriculum but to the informal and nonformal learning environments. These methods provide the environment that appears conducive to young men and young women’s learning style and therefore may provide a tangible impact to the STEM fields.

Several grants have been awarded that address the issue of this robotics curriculum and their impact in school systems, after school programs and boys and girls clubs. The NSF has provided increasing amounts of money toward this endeavor, therefore showing merit to what is being studied and progress being made in the area of robotics curriculum and how it effects STEM fields. Grants that have directly impacted this study are listed in Appendices I, J, and K.

In the not so distant past, biology was not a mainstream course. It was often a male gendered field of study, I sense the same is true for other STEM coursework. As
biology made its way to a core curriculum the subject became gender inclusive. We need to better prepare for our increasing technologically dependent future. One way is to expose all students to STEM courses. Nourbakhsh et al. (2005) and Rogers and Portsmore (2004) noted that female students in particular were more likely to appreciate learning with robots that traditional Science, Engineering and Technology (SET) techniques. Reasons cited include inclusiveness, collaborative nature and hands-on activities.

From the research I have gathered I make the following recommendations:

- each student needs to have the opportunity for exposure to robotics curriculum and its hand-on experiences;
- exposure needs to take place during the school day, not just as an option of an after school program;
- the course needs to be structured to include field trips, both virtual and physical; and
- each student needs exposure to professionals and emerging careers.

Summary

A robotics course does not teach programming alone, but also includes many skills that are needed in real life situations. Robotics fosters creativity. With robotics, there may be several solutions to a question (Beer, Chiel, & Drushel, 1999), hence building creativity that is needed for thinking technically. The robotics curriculum allows concrete ideas to be drawn from math and science concepts through experimentation. Student levels of interest and engagement are increased using robotics (Robinson, 2005; Rogers & Portsmore, 2004).
If more hands-on STEM courses namely robotics, could be offered as elective courses in our educational system, its popularity could grow. Any and all students could be exposed to these courses without negative connotations or stigmatisms.

Data provided by Nugent et al. (in press) revealed not only cognitive levels but attitudes increased with the 40-hour robotics curriculum intervention. The three hour intervention showed an increase in excitement for using robotics as learning tools, but little cognitive differences for pre and post tests. “Longitudinal studies of effects are rarely carried out. Such studies, however, provide the ultimate basis for determining the effectiveness of changes in student learning” (Connolly, as cited in Fairweather, n.d.).

Longitudinal studies are needed to follow the participants of the robotics curriculum and FLL competition through college. This could provide the needed data describing whether young women remain engaged in STEM coursework as a result of the curricula or the competitions. The time has come to make a difference and clearly demonstrate the results.

"Well-behaved women seldom make history." — Laurel Thatcher Ulrich, 2007
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Appendix A

Definition of Terms
**Definitions**

*Female Adolescent*—females in Middle school grades 5-9, approximate ages 10-16

*Competition*—Competition consists of showing predesigned, built and programmed robots, along with findings from real-world research projects the participants have been studying. Competition also includes a teamwork portion whereby the participants are given a challenge to solve and the judges observe their interactions.

*GIS-Geographical Information Systems*—A geographic information system (GIS) integrates hardware, software, and data for capturing, managing, analyzing, and displaying all forms of geographically referenced information.

*GPS-Global Positioning System*—A GPS is a U.S. space-based global navigation satellite system. It provides reliable positioning, navigation, and timing services to worldwide users on a continuous basis in all weather, day and night, anywhere on or near the Earth which has an unobstructed view of four or more GPS satellites.

*Informal learning process*—Informal learning process is defined as being guided by the learner, where learning takes place relatively spontaneously with no authority figure or mediator as the instructor.

*Mentor*—A mentor is someone who is known and trusted; who currently in any STEM field and shows interest in sharing his/her field of study.

*Non-formal learning situations*—Non-formal learning is defined as learning that takes place when guided by an instructor, teacher or volunteer.
Robotics Curriculum (specifically Gear Tech 2.1) — curriculum that brings together robotics, GPS (Global Positioning Systems) and GIS (Geographic Information Systems). Objectives include:

● Build and program robots
● Operate a handheld GPS receiver
● Put your science, technology, engineering, and math skills to work
● Explore the outdoors
● Apply robotics, GPS, and GIS technologies to geo-tracking, navigation, and mapmaking
● Learn about the role of information technology in natural resources and precision agriculture
● Find out about careers in science, technology, engineering, and mathematics including robotics, GPS/GIS, natural resource management and agricultural technology
● Complete fun challenges and have the opportunity to compete in a virtual competition with other youth across the country.
● Prepare to compete in a FIRST LEGO League®, GEAR-Tech-21 or local competition.

Role Model—A role model is someone who is looked upon as a good example to be followed; this person may or may not be known.

Scaling or Scaling-up—Scaling refers to taking a project from its current level to a higher level. A grant, “Scale-Up: National Robotics in 4-H: Workforce Skills for the 21st Century,” allows 4-H to expand its current program, offered mostly to Nebraska youth, to youth from across the United States.

STEM—Science, Technology, Engineering and Mathematical fields of study.
Appendix B

Institutional Review Board Approval
February 24, 2010

Kathy Norier
Agricultural Leadership, Education and Communication
420 Brooke Ave. Lincoln, NE 68528

James King
Agricultural Leadership, Education and Communication
300 AHU UNL 68503-0709

IRB Number: 2010021086EP
Project ID: 10352
Project Title: Encouraging Females in the STEM Fields

Dear Kathy:

This letter is to officially notify you of the approval of your project by the Institutional Review Board (IRB) for the Protection of Human Subjects. It is the Board's opinion that you have provided adequate safeguards for the rights and welfare of the participants in this study based on the information provided. Your proposal is in compliance with the Institution's Federal Wide Assurance (FWA) and the DHHS Regulations for the Protection of Human Subjects (45 CFR 46).

Date of IRB Review: 02/23/2010
You are authorized to implement this study as of the Date of Final Approval: 02/24/2010. This approval is Valid Until: 02/23/2011.

We wish to remind you that the principal investigator is responsible for reporting to this Board any of the following events within 48 hours of the event:

• Any serious event occurring on site or off site adverse events, injuries, direct deaths, or other problems which in the opinion of the local investigator was unanticipated, involved risk to subjects or others, and was possibly related to the research procedures;
• Any serious accidental or unintentional change to the IRB-approved protocol that involves risk or has the potential to occur;
• Any publication in the literature, safety monitoring report, interim result or other finding that indicates an unexpected change to the risk/benefit ratio of the research;
• Any breach in confidentiality or compromise in data privacy related to the subject or others;
• Any complaint of a subject that indicates an unanticipated risk or that cannot be resolved by the research staff.

For projects which continue beyond one year from the starting date, the IRB will request continuing review and update of the research project. Your study will be due for continuing review as indicated above. The investigator must also submit the Board when this study is finished or discontinued by completing the extended Protocol Final Report form and returning it to the Institutional Review Board.

If you have any questions, please contact the IRB office at 472-6985.

Sincerely,

[Signature]
Marla Staats, Ph.D.
Chair for the IRB
Appendix C

Parent Informed Consent Form
PARENTAL INFORMED CONSENT FORM

Encouraging Females in STEM fields

You are invited to permit your child to participate in this research study. The following information is provided in order to help you to make an informed decision whether or not to allow your child to participate. If you have any questions do not hesitate to ask. Your child is eligible to participate in this study because your child is in the ages of 9-16. Your child will also be asked if she is willing to participate. This study will take place at the end of the FLL and CEE/SoT competitions. The purpose of this study is to investigate the effectiveness of robotics and this competition as a tool to help students become more engaged in science, technology, engineering and mathematics.

This research consists of five focus groups; your child will only participate in one focus group. Each focus group will last approximately forty minutes. Your child will be asked several questions that describe her experiences with the competition and the yearlong informal learning experiences using the robotics curriculum.

There are no known risks associated with this research.

All responses will be kept in strict confidence. Your daughter’s name will not be included in the project or other documents. The data will be stored in a locked drawer in the investigator’s office and will only be seen by the investigators during the study and for two years after the study is complete. The information obtained in this study may be published in education journals but the data will be reported as aggregated data. If you have questions about this research you may call the investigator at 402-472-3399. You may ask questions before or during the study, either by calling the investigator at the above number or by email: knotter@uni.edu. If you have questions concerning your child’s rights as a research participant that have not been answered by the investigator or to report any concerns about the study, you may contact the University of Nebraska-Lincoln Institutional Review Board at 402-472-6965.

You are free to decide not to participate in this study or to withdraw at any time without adversely affecting your relationship with the investigator or the University of Nebraska. Your decision will not result in any loss of benefits to which you are otherwise entitled.

You are voluntarily making a decision whether or not to allow your child to participate in the research study. Your signature certifies that you have decided to allow your child to participate having read and understood the information presented. You will be given a copy of this consent form to keep.

Child’s Name

Signature of Parent

Kathy Notter, Primary Investigator
James King, Secondary Investigator

Date

Office: 402-472-3399
Office: 402-472-3022
Appendix D

Participant Informed Assent Form
YOUTH ASSENT FORM
Encouraging Females in STEM fields

You are invited to participate in this study because you are between the ages of 9-16 and we are interested in how your involvement in the FLL and CEENBoT after school programs and competition has affected your view of Science, Technology, Engineering and Mathematics (STEM). This study will take place after your competition. The purpose of this study is to determine how well your robotics coursework and this competition has helped you become more interested in science, technology, engineering and mathematics.

This research consists of five focus groups; you will be part of only one focus group. Each focus group will last approximately forty minutes. You will be asked several questions that describe your experiences with the competition and the yearlong after school programs using the robotics curriculum.

Your responses will be confidential; your answers will not be shared with anyone. We may publish a summary of everybody's responses but your name will never be used. You will be audio taped during the focus group session, but this audio tape will not be shared. Being in the study may help you learn reasons you and other members of the focus group became more interested in STEM curriculum. We will also ask your parents for their permission for you to do this study. Please talk this over with them before you decide whether or not to participate. You can decide to stop participating in the study at any time. If you have any questions at any time, please ask the researcher. If you check "yes," it means that you have decided to participate and have read everything that is on this form. You and your parents will be given a copy of this form to keep.

________ Yes, I would like to participate in the study.

________ No, I do not want to participate in the study.

Your Name ___________________________ Date ___________________________

Kathy Notter, Primary Investigator
James King, Secondary Investigator

Office: 402.472.3399
Office: 402.472.3022
Appendix E

Transcriptionist Confidentiality Agreement
I, _______________________, hereby agree that I will maintain confidentiality of all

tape-recorded interviews that I have been contracted to transcribe for the following research

project: Encouraging Females in STEM Fields. This means that I will not discuss or share any
tape-recorded or transcribed data with any individuals other than the researcher, Kathy Notter, or
her supervisor, Dr. Jim King. When the transcriptions are complete, I will return all audiotapes to
the researcher and will transfer all electronic files to the researcher. Upon confirmation of receipt
of these files by the researcher, I will destroy the originals.

(Signature of transcriptionist)  (Date)
Appendix F

Focus Group Questions
Focus Group Questions

1. When and why you did first started doing this (tinkering with robotics, science activities, and math activities?)

2. Tell me about your experiences and what led you to this competition. Share any funny stories that you, friends or family may have about your involvement in this competition?

3. What is the most fun thing you did at this competition or getting ready for this competition?

4. What things have been supportive? What things have been challenging?

5. Describe what made you feel good about this competition?

6. Are there other questions I should be asking the other girls?
Appendix G

Focus Group Transcript Sample
Focus Group Transcript Sample

PI: My name is PI Notter and I am from the University of Nebraska and I am doing research that’s trying to get girls more involved in the STEM fields which is Science, Technology, Engineering, Mathematics and what we’re trying to do to find out, what we are trying to find out today is what got you here? What you do when you got here and what are you going to do now? Ok? Mediator is going to be facilitating our discussion today so I am going to kind of turn things over to her. Before you leave there is one more form that I need you girls to sign and you’ll notice that I forgot to put a line where you’re supposed to sign so just check that yes you’ve agreed to talk to us and basically it says I’m here, I’m talking to you, there is nothing terrible that is going to happen to you while you are here. We’re not going to make you do anything nasty or harmful we just want to talk to you guys. But I want you to be as honest and open as you can. Nobody is going to hear this information other than me and Mediator and your name is not going to be attached to anything. But we are going to go around the room and kind of introduce ourselves a little bit. Ok? Any questions? Ok.

Mediator: And when we ask you guys questions too, there is not a right answer and there is not a wrong answer. It is just totally what you are thinking and what your experience is ok? Sound good? Alright. First I want to go around the room and like PI said kind of introduce ourselves. Um, I want you to tell us your first name, you don’t have to tell us your last name, just your first name, and then pick one thing that you are wearing today and tell us how that represents you. So I’ll start. My name is Mediator and I am going to tell you about my rings here. They were my great grandmother’s wedding rings and family is very important to me so it is really special for me to be able to have these. Do you want to go next?

Sadie: Um, Sadie and uh I’m wearing a sweatshirt that says soccer because soccer is my favorite sport and I’ve played it since I was real little.

Mediator: Excellent, thank you for sharing that.

Pamela: My name’s Pamela and Pamela and, I don’t think I have anything special on.

Mediator: What about your shirt?

Pamela: Well, um it says NEXT and if you cut off the E then it’s NXT.

Mediator: That’s pretty special. That’s pretty cool

Maddie: My name is Maddie and my shoe laces are special because they are green and my favorite color is green.

Mediator: Perfect

Tina: My name’s Tina and my sweatshirt is cool because I go to this school and I really like school.
**Mediator:** Good, awesome.

**Haley:** My name’s Haley and (giggle) um,

**Sue:** Say something I don’t know what you’re looking at me for. I don’t know. Ok just pick something Haley you have something special on you.

**Haley:** This hoodie.

**Mediator:** Tell us about that hoodie.

**Sue:** Ok Haley stand up (giggles)

**PI:** Ok

**Mediator:** Alright

**Haley:** It’s not funny tell her why

**Haley:** Um, uh I don’t really know

**Sue:** It’s got our last names

**Mediator:** Your last names

**PI:** Mm k

**Mediator:** That is pretty special. It’s really cool. Thank you.

**Haley:** My name’s Haley and my pony tail because my favorite color is purple.

**Mediator:** Awesome

**Alexis:** My name’s Alexis because my earrings, my earrings because I like to wear different colors.

**Mediator:** Very cool.

Oh, those are cool

**Ebony:** My name’s Ebony and my shoes because they have peace signs on them.

**Allison:** My name’s Allison and uh the color of the shirt yellow because I like yellow.

**Mediator:** Awesome, thanks for sharing that you guys. Um the next thing I want to know is what is the most exciting thing that has happened here for you guys? If anyone has an idea just let me know.

**Sue:** Um getting our points for our like robotics
Mediator: Can you tell me that again sorry.

Sue: Getting our points when we got our, when our robot

Mediator: How did you guys do?

Sue: Good

Mediator: Awesome yeah

Meeting new people from all over the place.

Mediator: They have the same interests as you too that’s exciting.

Getting pictures taken with the governor and watching our friends compete.

Mediator: Cool very good, go ahead

Pamela: Um getting to know other people and winning 400

Mediator: 400. Nice! Yeah

Getting to do our presentation.

Mediator: Tell me about your presentation.

Well we had a bus of Boys and Girls club sign and Kirn Middle School in Council Bluffs and it was pretty much just like a sketch.

Mediator: Cool

It was fun

Mediator: What was it about?

It was about kids getting a ride over to Boys and Girls Club because some places don’t have transportation.

Mediator: Good. Anything else exciting about today? Yeah

Getting to see my friends when I usually don’t get to see them on the weekends

Mediator: Oh, there you go, very good, awesome. Alright so can you guys tell us something exciting um that happened when you guys were getting ready for this competition? Yeah

Getting to miss one of our classes.

Mediator: What class did you miss?

Band
**Mediator:** Did you? Were you guys practicing during that time or?

Mmhumm

**Mediator:** Very nice. Yeah (4:00)

Programming our robots.

**Mediator:** Tell me more about that

Um we had to program it to um do all like do all the tasks and everything.

**Mediator:** That’s cool that’s exciting for you. Yeah

Making um our robot um extension so that we can maneuver around the course.

**Mediator:** So what, why was that exciting for you?

It was exciting because I got to spend time with my friends and yeah.

**Mediator:** Excellent, good, do you have, no? Anyone else? Did anything happen? Yeah

Well when we were getting ready I figured out I would be competing against my brother in some competitions and that was kind of exciting because we both helped, would help each other.

**Mediator:** Good that’s awesome! Does anyone else competing against a sibling or a cousin or anything? You are?

I’m competing against my friend Maddie.

**Mediator:** That is almost the same too, yeah. Good.

**PI:** How do you feel about that?

**Sarah:** Um in some ways I want to win and in some ways I want to lose. Yeah but mostly I want to win.

(laughter)

**Mediator:** Yeah

**Pamela:** Something unique about us is the fourth, the fourth mission it has four people that work it, it um two people come at, a, at up at a time on each whatever you call it, um.

**Mediator:** Like each round?

**Pamela:** Yeah each round

**Mediator:** Ok
Pamela: And um my brother goes with me or my brother goes with a different person or my brother goes with a different person so I think that’s kind of unique about that part.

Mediator: That is

Pamela: And we’re, we don’t use Jigs.

Mediator: What do you use?

Pamela: We mostly line it up with the walls.

Mediator: Humm

Pamela: Trying to use the walls and stuff and the first year we’ve never, um we’ve never um had jigs. (6:00)

Mediator: Really? And has it worked out for you? Is that a good strategy to use? Nice, good. Do you guys have any funny stories about your friends and family regarding this competition like you, have they said anything funny to you guys about it or? Can you guys share your funny stories?

PI: Or when you were getting ready for it did something happen or?

Mediator: Yeah

Well my friend ate some jelly beans from another group and then she ate them all at once and then she made this funny face.

Mediator: (laughing) Yeah

When we were making our bus for our skit, Um Miss Taylor, a counselor that works and the Boys and Girls club, she came in and said it looked like a giant Twinkie.

Mediator: Like a Twinkie?

(laughter)

Mediator: Go ahead

Um my sister was laughing at me because I had to get up at 6 and usually I don’t get up then on a Saturday

Mediator: MMhmhm, you can go

Um one of my friends and some of my family call me nerd because yeah. Although my dad is in the engineering business.

Mediator: He is? Do any of you, do any of the rest of you know anybody that’s in engineering or mathematics or
He’s going to school for it

**Mediator:** Science or do any of you have relatives?

**Pamela:** My brother he knows a friend that’s in that.

**Mediator:** Good

**Pamela:** And um one thing that was funny um, my part in the skit I say I’m a consumer and my name is Connie Sumer. And um what I say is, “Just about a few weeks ago I try to use my debit card but it wouldn’t, uh to purchase gasoline but it wouldn’t take my card. I called my bank and they told me I had no money left in my account and I just made a deposit. I think somebody stole my credit card information.” And so the reporter guy he said, (8:00) “Oh well I thought you still had your card” and I’m supposed to say something but I started coughing and then he said, “Did you eat it?” And I started laughing and coughing at the same time.

**Mediator:** Oh no (laughter). That is pretty funny. Any other funny stories of family or friends or anything? Yeah

Once when my sister was a little bit younger than she is now um, we were at Great Wolf Lodge and she ran into the door.

**Mediator:** Did she?

It was funny.

**Mediator:** Alright. Can you guys tell me a little bit about what got you started doing robotics? Yeah

Um I my dad’s in the military so we move around I was in Nema, Arizona and we were doing Oddesey of the Mind and in Nebraska we don’t have that.

**Mediator:** Yeah

Or I don’t go to schools where it is so I decided to do robotics because I like robots, robots and programming and all that stuff

**Mediator:** Awesome. That is awesome. Yeah

**Pamela:** Um, I didn’t really care about doing it and my brother was first just gonna do it and then they said they needed a girl on the team so I was like ok fine I’ll do it since I’m now the only girl and I did it.

**Mediator:** So how do you feel about that now?

**Pamela:** It’s fun.

**Mediator:** It is?
Pamela: I’m glad I did it.

Mediator: Do you think you’re going to do it next year too? Yeah? Yeah

Well last year in English class we did a lot with robots and stuff, the scenebot and I really like it so I ended up doing the competition last year

Mediator: Nice, so you did it last year too?

Mmhumm

Mediator: Did any of the rest of you do it last year. So this is your second year then?

Mmhumm

Mediator: Excellent. And who’s all planning on doing it next year? Everybody? That’s awesome!

Except for one person

Mediator: Not so excited about it? Can you tell us why you are having

I’m moving to South Dakota

Mediator: Your what?

PI: Oh you’re moving

Mediator: Oh they don’t have it? Oh. If they did have it would you be interested (10:00)

Yeah

Mediator: In doing it again? Good. Alright can you guys tell us a little bit about if anybody has been supportive to you or if you’ve felt supported in any way about, around robotics or if you’ve had any really big challenges too? Yeah

Um my, my dad and my mom and my school

Mediator: Have been supportive? Good. You said too earlier that somebody had called you a nerd before. Was that kind of discouraging?

Sort of

Mediator: How did you feel, like how did you handle that?

Well, I just blew it off I’m like ok I know what I am and this is fun for me

Mediator: Good, good. Anybody else? Yeah

Haley: My parents
Mediator: Your parents have been supportive of you? Good

I’ve had a lot of family here today like a couple of my aunts and my brother was always there so.

Mediator: That’s nice. To come see you compete?

Yeah

Mediator: You’ve got a lot of support. Yeah

Pamela: Well um we gave our parents and their siblings and stuff our shirts and they’ve been supportive just like my mom has a shirt on right now too.

Mediator: Does that help you feel supported when you see a bunch of people around you wearing your shirts?

Yippee

Mediator: Oh yeah. Yeah

Sue: My parents and my team coach

Mediator: Your parents and your team coach. Good, who else? Yeah

The people at PKI

Mediator: Have they been supportive?

Yeah

Mediator: Good

My mom. She’s our tree

Mediator: She’s your tree?

She’s a tree full of (inaudible) for our team

Sue: She brought lots of snacks for us

Mediator: She did?

Like probably a year worth of snacks

Mediator: Wow. Has that been helpful to you guys?

Mmhumm It was yummy

Mediator: Yummy, Good. Yeah
**Jennifer:** Um our coach has been really supportive. She was cheering us on, we could always hear her.

**Mediator:** That’s awesome. Did that help you, motivate you

Yeah *(12:00)*

**Mediator:** To do even better? Good yeah

**Pamela:** Well I noticed somebody I don’t know what team it was but they were supporting other teams.

**Mediator:** So the support around you even if it’s not your team right?

**Pamela:** Yeah

**Mediator:** That’s good too. Yeah

**Sue:** When we were practicing for our time to go in the competition and another team came over and said, “good luck.”

**Mediator:** Wow that was nice. Did you guys do that to other teams too?

**Sue:** Yeah

**Mediator:** To help support them? Excellent. It sounds like you guys are really supportive of each other. Can you tell me what the most fun thing you did today was? Go ahead

Play on the playground

**Mediator:** Ok

Passing out balls

**Mediator:** You guys passed out balls huh?

Mmhumm

**Mediator:** Fun. Yeah

Lunch

**Mediator:** Lunch. Yep

When we were doing the skit

**Mediator:** Doing the skit, yeah

Going against people
Mediator: Oh going against people, like the competition part? Excellent

Competition

Mediator: Competition

Competition

Mediator: Competition. Yeah

Competition

Mediator: All right. Do you guys do anything else competitive? Or is it just the robotics? Yeah

I did volleyball

Mediator: You did

Sue: I play bas, I play basketball

Mediator: Good

I play a lot of sports

Mediator: You do. Do you guys like to competition part of it then?

Yeah

Yeah

Yeah

That’s the best part

Mediator: It is? Yeah go ahead

I play volleyball

Mediator: You do? Good, Yeah

Um I do basketball and I run cross country

Mediator: Excellent. And those are both, you like the competition in them too?

Yeah

I do soccer

Mediator: Good
I do volleyball and I run track

**Mediator:** You guys are busy

I play basketball and I’m going to run track

**Mediator:** Awesome

PI: There’s one more

**Mediator:** ooh what?

PI: One more

**Mediator:** One more sorry!

Soccer and volleyball

**Mediator:** Awesome and you like the competition in those? Is it the same or different than the competition here?

Different

Different

Different

Different

**Mediator:** Tell, tell me why. *(14:00)*

Well because for one track like you get to run around all the time and you get and you have to like exercise to get warmed up.

**Mediator:** Did you do anything to get warmed up for this?

Um not really.

**Mediator:** No? Ok, you practice?

Yeah you practice

**Mediator:** Good yeah

This isn’t like a physical sport

**Mediator:** Mmhumm

It’s not like on like we’re not competing like with each other, we’re competing against eachother
Mediator: Yeah

Um in sports you have to be like physically fit and this is like a lot of strategies

Mediator: Mmhumm. So it’s more mental you think

PI: You guys sound very sports minded. What if there was a competition in robotics on the same day as one of the sports that you’re involved in? What would you choose? And Why?

Mediator: Ooh

PI: Which would you choose?

Uh robotics because um you can use math and technology.

PI: Ok

Um I’d probably choose robotics

PI: Ok

Because of it, usually I only get to do this once a year and basketball is I have a whole season.

Well that depends. Like I’d choose robotics probably first but I can usually make a way to make them work both ways because that’s what happened last year was I had a volleyball tournament the same day.

Mediator: Oh really? And you made it work out

Yeah I can make it work out

Mediator: Nice, good

I would probably do track because track you can like win medals and trophies.

Mediator: Good thank you. Yeah

Um I would choose robotics because I have um I had basketball every Friday and then I had cross country every Saturday for about six months. (16:00)

Mediator: And robotics is just this one thing then?

Yeah

Mediator: Ok

Pamela: Well the question before asked um would, would, what’s different about sports and

Mediator: Uh huh the competition part
Pamela: And I think it’s because um soccer you don’t have to make, you don’t have to make a plan what to do you just do it however you do it.

Mediator: Mmm

Pamela: And then robotics you have to make sure that you can do the right things and get the strategy down.

Mediator: Do you like that part of it?

Pamela: Mmhmm, and I think I would probably pick robotics instead of soccer because I really like robotics and

Mediator: Did everyone else get a chance to share on that one if they wanted to? Alright can you guys describe your feelings today? I’ve seen a lot of smiles, I’ve seen a lot of excitement, I’m wondering how you are feeling, what made you feel good today?

Sue: Happy

Mediator: You are? What made you feel that way?

Sue: Um getting points on the competition

I’m happy and excited. I’m excited because I’m going to the competition and I really like to compete.

Mediator: Good. Yeah

I’m excited because this year’s my first time and it’s my first time doing things and I get to learn a lot.

Sue: Me too just like her It’s my first time and I’m kind of excited to learn everything about it that I can

Mediator: Awesome

I’m really excited because it’s something different from what I normally do and we did really good so

Mediator: You did really good

Yeah

Mediator: So that’s a good reinforcing thing right there yeah. Did you have an idea?

Haley: I’m excited just like Haley is because uh I don’t know why but.

Mediator: The competition? (18:00)
Haley: I just don’t know why I’m excited.

Mediator: Ok, but you are excited?

Haley: Uh huh

Mediator: Ok. So what do you guys think like from you have learned today and what has happened today, what do you think this will affect your future at all?

(phone ringing)

You might know like things about whatever you learn in um robotics like you might learn and like you might get a job that involves skews and like they didn’t match, how would you make them match?

Mediator: So the problem solving piece of it?

Yeah

Mediator: Good. Yeah

Um it helps me with math and science

Mediator: Awesome

Sue: Maybe one of us might get into this, want to get into this when we get older.

Um kind of like what she said for math and science.

Mediator: Get some more experience and more knowledge about it? Yeah. So, what do you guys all want to do? Have you guys thought about what you want to do when you grow up?

Um I would like to become a doctor

Mediator: You would? Ok, yeah

Be a teacher

Mediator: Be a teacher, good

Probably a teacher

Mediator: Teacher

Um a doctor

Teacher

Mediator: Teacher
Um (pause) I have no clue

**Mediator:** You don’t have any idea? That’s ok! You still have a long time to think about it

Maybe a zoo keeper because I like animals

Teacher

**Mediator:** Teacher. No idea? Mm, ok yeah

**Sue:** Um like I said a teacher and whatever I become and just end up to be I guess

**Mediator:** Good. Yeah

A photographer

**Mediator:** Photographer, that’s awesome. Do you like taking pictures now?

Mmhumm

**Mediator:** Good that’s nice. Is there anything else you guys want to tell us about your experience today or what lead you to be here or anything else at all about the camp or the competition or anything? Yeah

Well usually my brother and I don’t get a long and this really like it both so we get along when we do this.

**Mediator:** That’s good

**PI:** And did you say you competed against him?

In the creativity part

**PI:** How did that go?

Well we don’t know yet. At the end of the day

**Mediator:** But you said you were helping each other right?

Yeah

**Mediator:** With it?

Yeah

**Mediator:** That’s cool. Yeah

**Sue:** Kind of how we were, like I said when we were kind of like practicing and one of the other teams came over and they saw what we were doing they would like help us, like tell us what we could do better.
Mediator: The other teams were helping you too?

And we would help them with some things that they needed

Mediator: Nice. Alright, can you guys think of any other questions that we didn’t ask you that would have been helpful for us to get some more information?

PI: How did you first find out about, I know screenbot works a little bit different but for the FLL how did you find out about the competition? Are you in the 4H curriculum? Are you doing and after school program?

Sue: Um Boys and Girls Club

PI: Ok, so you meet like once a week or

Sue: We had to, we meet everyday er we meet on Monday and Tuesdays but when it came closer to the competition we would meet everyday

PI: Ok

Same with us

PI: Ok

Same here, we went to um Boys and Girls Club and, but we did it every day but Monday and Friday

PI: Ok. And since we do have moms and coaches in the room, what did you notice about the girls that maybe was different in the beginning then to now? Have you noticed any changes? Have you um seen particular growth in any area?

I think it’s easier for them to cooperate because frankly they have no other choice um also I’ve seen a few of the girls that were more bashful become a little more assertive um and I think that the way they worked in concert with the one boy that we had on our team was impressive. Um I don’t think there was really a hierarchy or a gender, you know, battle for control. I think everybody kind of, they didn’t necessarily assume roles but they all stepped up to the plate to help with all the roles.

PI: Do you think it would have been different had you had more boys in the mix?

Well, originally we had two boys and one of the boys backed out and I, I don’t believe it was because he felt overpowered or anything like that but I don’t, I don’t think so. I think in this situation the platform that we were given with which to work definitely sets it up to be more equal than something where it would be more direct competition as opposed to more preparation. Because really and truly this is more about the preparation that you take as opposed to the competition. I think had it been reversed, I think it would have been a different outcome for the, for the girls.

PI: This is our most competitive group that we’ve spoken to today
Mediator: Uh huh

PI: Every, that hasn’t come up a, a lot as far as the competition so that was a nice surprise to see with this group.

You know I can speak as a, I’m the director at the club that they are at, not necessarily coach and I’m a mom um from the club perspective when they started, our team was much larger and it had a lot more boys and it was interesting to see how they dropped out along the way. Um there were less girls (24:00) that dropped out. It seemed as though the girls once they signed up for the commitment, um stepped to the commitment as much time as it took and the other thing I saw with this group of girls is right now our team is equal because we have three boys and three girls um is they handle themselves really well which kind of surprised me. I was a little concerned that maybe they would, kind of, you know let the boys take over but they all handled themselves very well and um really took control um of some of the aspects of it and really stepped up um which we don’t always necessarily see. Um but I can just speak, you know on the mom’s side of it seeing the change in my daughter I was very surprised um. It’s not something that I thought she would have done. Um and then to sit back and watch um her taking charge and almost being bossy at some points, um telling people what to do and how to do it. Um, something that maybe she needs to work on but I was really impressed and I was happy to see her do that and take an interest in it. Um and now that she’s done it I’m happy to say that she seems like she wants to do it again and so I think it’s been a good way to introduce her to math and science, um in a way maybe she doesn’t necessarily know she is doing because math is her least favorite thing in school it is something that she struggles with but this has been a good way for her to you know, just utilize those skills and not necessarily be in a way that isn’t maybe so direct and she is, she is learning a different way, hands on. And she’s learning other things about um technology that maybe she wouldn’t have. Things that she didn’t necessarily you know, know going into it so. Um, I, I think it’s been good for all of them and I think it’s, I mean it’s another way to introduce that’s not necessarily so in your face. (26:00) I mean it’s something hands on and it also builds a lot of team work it seems like to the girls and that’s important to them.

PI: Ok, any other comments? Oh, ok, Pamela?

Pamela: Well, one of the things that I really liked was just getting together to have some fun and having, maybe throwing a party or something or just getting together to play around. Because like we kind of carpool in the car and we play our DS’s on the way there and on the way back and it just makes it more fun than just doing the robots and stuff

The DS’s they play, they have some games that they can join together so it’s quite interesting hearing their conversations

Mediator: Huh

But what I wanted to say about your question about girls is Pamela tends to be quiet. Not that you could tell that today. And so to see her speak up and to speak with confidence is what I’ve liked um to see in her.

Mediator: Good. Thank you for sharing that
PI: Ok, if you have consent forms that have been signed and I have not gotten them yet, please do not leave until, you have to sign a youth assent from that basically says that you were willing to talk to me so I’m going to have you guys sign that before you leave. There’s some, there you go, they are on that back table there. Thank you very much. Thank you

Mediator: And thank you all very much for taking the time to come up here and do this

PI: Yes

Mediator: We really really appreciate it

(signing papers) (28:00)

PI: Excellent, thank you very much for coming I appreciate all of the information that you shared, you did wonderful. Thank you

Do we come back once and a while?

Mediator: What was that?

Do we come back once and a while and do this?

No

Mediator: Later on this year?

Yeah

Mediator: I don’t, I don’t know, I think this is a one, once a year thing for the competition. If you were able to come back again, would you want to?

Probably

PI: You know the majority of the people that work for me are all men and it’s just, we’re trying to get that, that changed.

You’ve got to start young though that’s why they,

PI: That’s what

Decide whether or not they’re good at it.

PI: That’s what I’m trying to observe here so the kiddo at the middle school age if not younger and then constantly, thank you very much Pamela, making it available because what these guys are going to do in the future, those jobs haven’t been created yet. They are not even, we don’t even know.

Like when I want to college you had to take programming and my first counselor was a male and he was like, are you sure you want to take this? It’s a little tricky (inaudible)
**PI:** There’s a lot of that that happens in the background *(30:00)*

(inaudible)

And now she likes it

**PI:** She seemed very comfortable here

(inaudible)

(Thank yous)
Appendix H

Sample Field Notes
<table>
<thead>
<tr>
<th>Mixed age group. The younger ones were gigglier than the older girls.</th>
<th>“meeting other people that have the same thing in common with you”</th>
</tr>
</thead>
<tbody>
<tr>
<td>One girl was not going to do the curriculum but decided to. Then decided she would not be on the team for the competition. They needed a girl on the team so she joined and found she really liked it. She definitely wants to be part of the team next year.</td>
<td>Competition rated very high for this group. One participant was competing against her brother and she was very excited about it. Even though they helped each other, they wanted to compete against each other</td>
</tr>
<tr>
<td>Everyone in this group was in year two of competitions, with only one exception.</td>
<td>Two participants in this group were friends but on different teams. “in some ways I want to win and to lose, but mostly to win” and they both giggled. They both felt the same way.</td>
</tr>
<tr>
<td>One girl was called a nerd by friends when she said she wanted to be part of this event (and take the courses). She shrugged her shoulders and said “it didn’t matter, I know who I am.” I knew it was fun for me.</td>
<td>Several in this group had lots of family here; aunts, uncles and brother. “my mom is wearing her shirt now” showing support for her daughter. Our coach was very supportive, we could always hear her above the crowd, that was great.</td>
</tr>
<tr>
<td>Everyone took for granted how supportive other teams were. They all wished each other luck just before competing.</td>
<td>Most participants in this group were very competitive but in a friendly way. They all participated in other sports, volleyball, basketball, soccer, and track.</td>
</tr>
<tr>
<td>---</td>
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<tr>
<td>What do you think about the competition? “it’s the best part” this group still liked being in the skit and hanging around with friends but competition was the most fun.</td>
<td></td>
</tr>
<tr>
<td>Comparing the competition to sports, each participant said it was different. This felt like they were competing against themselves and not others. More strategies had to be initiated here, not like with sports. With this you have to make a plan.</td>
<td>Each participant said if this competition and their sporting event were held on the same day, they would choose the robotics competition. It is only held once a year and the sports had all season.</td>
</tr>
<tr>
<td>Discussing their feelings: I really excited because this is different from what I normally do and we did really good today.</td>
<td>One participant and her brother normally don’t get along but this is a common interest and they work well together.</td>
</tr>
<tr>
<td>Participants were meeting everyday to prepare for the competition.</td>
<td></td>
</tr>
</tbody>
</table>
Appendix I

Awarded Grant Number 525111
SPIRIT: Silicon Prairie Initiative on Robotics in IT

Abstract

The "Silicon Prairie Initiative on Robotics in IT" (SPIRIT), a collaboration between the University of Nebraska and Omaha Public Schools, is a three-year Comprehensive Computer Science Program for Students and Teachers. SPIRIT targets 105 science and mathematics teachers in grades 7-9, each of whom receives more than 100 hours of professional development and 50 hours of follow-up support in developing in-school curricular activities. More than 9,000 students are expected to participate through in-school and summer programs.

The centerpiece of the project is a university level TekBot (TM) learning platform that is
being adapted to the middle school level. This platform can be used to demonstrate basic applications in wireless, video and signal processing, sensors, video displays, electronics, control systems, embedded systems, digital logic and introductory programming. The curriculum to be developed in the project employs TekBots as a fundamental strategy for problem-based instructional activities. It is adaptable, expandable and cost-effective, providing learning experiences that can extend into high school and college. Results will be disseminated through publications and presentations, teacher workshops, displays prepared for the Omaha Children's Museum and collaborations with other universities using robotics platforms. An interactive, dynamic website will be created with modules and tutorials, downloadable programs, chat rooms and links to robotics research.

**PUBLICATIONS PRODUCED AS A RESULT OF THIS RESEARCH**

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Barker, B.S., Grandgenett, N.F., Nugent, G., Ansero, J., Hampton, A.  

Barker, B.S., Grandgenett, N.F., Nugent, G., Ansero, J., Hampton, A.  

Barker, B., Grandgenett, N. & Nugent, G.  

Barker, B., Grandgenett, N., Nugent, G., Adamchuk, V.G.  

Barker, B., Nugent, G., Grandgenett, N., Adamchuk, V.G.  

Barker, B.S., Nugent, G., Grandgenett, N.F.  

Barker, B.S., Nugent, G., Grandgenett, N.F., Hampton, A.  

Gilmore, A., Saeh, R., Grandgenett, N., Chen, B.  

Grandgenett, N. F., Harris, J., Hainer, M.  

Grandgenett, N. F., Topp, N.W.  

Nugent, G., Barker, B., & Grandgenett, N.  

Nugent, G., Barker, B., Grandgenett, N. & Adamchuk, V.  

Nugent, G., Barker, B., Toland, M., Grandgenett, N., Hampton, A. & Adamchuk
being adapted to the middle school level. This platform can be used to demonstrate basic applications in wireless, video and signal processing, sensors, video displays, electronics, control systems, embedded systems, digital logic and introductory programming. The curriculum to be developed in the project employs TekDots as a fundamental strategy for problem-based instructional activities. It is adaptable, expandable and cost-effective, providing learning experiences that can extend into high school and college. Results will be disseminated through publications and presentations, teacher workshops, displays prepared for the Omaha Children’s Museum and collaborations with other universities using robotics platforms. An interactive, dynamic website will be created with modules and tutorials, uploadable programs, chat rooms and links to robotics research.

**PUBLICATIONS PRODUCED AS A RESULT OF THIS RESEARCH**

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Nugent, G., Barker, B., Toland, M., Grandgenett, N., Hampton, A. & Adamschuk
http://www.nsf.gov/awardsearch/showAward.do?AwardNumber=0525111


CONFERENCE PROCEEDINGS PRODUCED AS A RESULT OF THIS RESEARCH


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Appendix J

Awarded Grant Number 624591
Award Abstract #0624591

Robotics and GPS/GIS in 4-H: Workforce Skills for the 21st Century

NSF Org: DRL
Division of Research on Learning in Formal and Informal Settings (DRL)

Initial Amendment Date: September 22, 2006
Latest Amendment Date: September 13, 2007
Award Number: 0624591
Award Instrument: Continuing grant
Program Manager: Arlene M. de Struke
DRL Division of Research on Learning in Formal and Informal Settings (DRL)
Enr Directorate for Education & Human Resources
Start Date: October 1, 2006
Expires: September 30, 2010 (Estimated)
Awarded Amount to Date: $884,139
Investigator(s): Bradley Barker, barker@neb.edu (Principal Investigator)
Vladimir Ademchuk (Co-Investigator)
Sponsor: University of Nebraska-Lincoln
312 N 24TH STREET
LINCOLN, NE 68588 402/472-1825
NSF Program(s): ITEST
Field Application(s): 0000099 Other Applications NEC,
0116000 Human Subjects
Program Reference Code(s): SMET, 9177, 9150
Program Element Code(s): 7227

ABSTRACT

The University of Nebraska-Lincoln, in partnership with Nebraska 4-H, will build upon an existing collaboration with Carnegie Mellon University and Carnegie's Robotics Curriculum program to produce an innovative program focusing on Robotics, Global Positioning Satellites (GPS) and Geographic Information Systems (GIS), as applied to the domain of precision agriculture and environmental science. The program aims to improve STEM learning outcomes, attitudes towards science and career path development of rural youth ages 12-15. Evaluation efforts will test how STEM experiences delivered via the 4-H informal learning model supports interest in STEM careers. The target population consists of 200 youth in 25 4-H clubs, as well as 50 4-H leaders and parents, the latter to receive professional development instruction in summer camps. The project operates year-round through the 4H clubs, and provides a summer program. The program will use existing 4H and Carnegie Mellon robotics curricula of 50 lessons and 130 hours of instruction, and will develop ten additional lessons of 30 hours in GIS and GPS. The pedagogical approach is the "4H experiential model," adapted from Kolb (1984).
PUBLICATIONS PRODUCED AS A RESULT OF THIS RESEARCH


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Appendix K

Awarded Grant Number 833403
Award Abstract #0833403

Scale-Up: National Robotics in 4-H: Workforce Skills for the 21st Century

NSF Org: DRL
Division of Research on Learning in Formal and Informal Settings (DRL)

Initial Amendment Date: September 15, 2008

Latest Amendment Date: December 16, 2009

Award Number: 0833403

Award Instrument: Continuing grant

Program Manager: Gerhard L. Selinger
DRL Division of Research on Learning in Formal and Informal Settings (DRL)
EHRL Directorate for Education & Human Resources

Start Date: October 1, 2008

Expires: September 30, 2011 (Estimated)

Awarded Amount to Date: $149,983

Investigator(s): Bradley Barker (barker@unl.edu, Principal Investigator)
Vacheslav Adamchuk (Co-Principal Investigator)

Sponsor: University of Nebraska-Lincoln
312 N 14Th STREET
LINCOLN, NE 68588 402/472-1825

NSF Program(s): ITEST

Field Application(s): 0000099 Other Applications, 0116000 Human Subjects

Program Reference Code(s): SMET, 9177, 9150

Program Element Code(s): 7227

ABSTRACT

Robotics and GPS/GIS in 4-H: Workforce Skills for the 21st Century is a five-year scale-up project to use 4-H clubs to prepare middle school youth for the STEM workplace. The project builds on and extends an existing research-based ITEST project by developing and testing new, national curricula to introduce basic technology skills, foster problem-solving and inquiry skills, and encourage teamwork. A professional development model to support youth learning of concepts focused on information and communications technology is designed and delivered to adult volunteers, after-school educators, and parents. The participation of girls and underrepresented populations is broadened through opportunities for collaboration and social networking and infusing cultural awareness within the project deliverables. The impact of these activities on youth STEM literacy, attitudes and workplace skills is documented. Research is performed to better understand how hands-on, inquiry-based robotics and GPS/GIS activities presented in an informal learning environment can effectively interest and prepare youth for the STEM workforce. Research questions include measures of how educational robotics interventions impact youth STEM literacy, workforce skills, and attitudes about...
STEM content. The research also investigates the use of the 4-H robotics curriculum to positively impact instructional practice of informal educators, their STEM content knowledge and their confidence.

**PUBLICATIONS PRODUCED AS A RESULT OF THIS RESEARCH**


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The National Science Foundation, 4201 Wilson Boulevard, Arlington, Virginia 22230, USA
Tel: (703) 292-5111, FAX: (800) 877-9339 | TDD: (800) 281-8749

Last Updated: April 2, 2007
Appendix L

Rules for Robotic Project
Rules for the Robot project

GRACIOUS PROFESSIONALISM
- You are “Gracious Professionals.” This means you are competing hard against PROBLEMS, while treating PEOPLE with respect and kindness - people from your own team as well people from other teams.
- You build onto other people’s ideas instead of resisting or defeating them.

PURPOSE
Interest in engineering innovation…
- FLL is a technical experience so fun, you forget it’s technical. Soon you realize technical is fun - and want more.
- FLL uses competition as an exciting motivator to get you to come up with ideas, solutions, processes, and inventions no one has ever seen before.

AUTONOMY
- The FLL Robot Game is to be played by an “autonomous” robot. That means you’re not supposed to influence it while it’s doing its work.
- But most teams need to intercept their robot once or more during the match. So you’re allowed to do that, but it always forces a restart from Base, and sometimes, there’s a penalty.

IF A DETAIL ISN’T MENTIONED, THEN IT DOESN’T MATTER
Assuming you have read all the missions, rules, and Game Q&A carefully…
- If no particular method is required, then any method is okay.
- If something is not specifically required, then you don’t have to do it.
- If there’s no restriction against something, then it’s allowed.
- There are no hidden requirements or restrictions.
- But there are hidden freedoms - in what the rules do not say.

GAME RULES
1 - PARTICIPATION
- The maximum allowable team size is ten members, not including coaches and mentors.
- See the FIRST LEGO League Coaches’ Handbook for allowable ages.
- At the tournament, only two team members at a time are allowed right up at the competition table except during repair emergencies.
- The rest of the team must stay back from the table, but close enough for different members to tag in or out as desired at any time. Specific positioning is decided by the head officials running each tournament.
2 - PARTS
This rule is not only about the robot. It also covers all of the attachments and strategic objects you bring to the competition area…

- Everything you compete with must be made of LEGO elements in original factory condition, except LEGO string and tubing, which you may cut to length. Exception: You can reference a paper list to keep track of programs.
- There are no restrictions on the quantities or sources of non-electric LEGO elements, except that factory-made wind-up/pull-back “motors” are not allowed. Pneumatics is allowed.
- The electric elements used must be the LEGO MINDSTORMS type, and the total number of electric elements you may use in one match is limited as follows:

<table>
<thead>
<tr>
<th>For RCX users:</th>
<th>For NXT users:</th>
</tr>
</thead>
<tbody>
<tr>
<td>RCX controller (1)</td>
<td>NXT controller (1)</td>
</tr>
<tr>
<td>motors (3)</td>
<td>motors (3)</td>
</tr>
<tr>
<td>touch sensors (2)</td>
<td>touch sensors (2)</td>
</tr>
<tr>
<td>light sensors (2)</td>
<td>light sensors (2)</td>
</tr>
<tr>
<td>lamp (1)</td>
<td>lamp (1)</td>
</tr>
<tr>
<td>rotation sensors (3)</td>
<td>rotation sensors (3 minus the number of NXT motors present)</td>
</tr>
<tr>
<td>3rd touch OR light sensor (1)</td>
<td>ultrasonic sensor (1)</td>
</tr>
</tbody>
</table>

- Example 1: If your robot has three motors, you may not have any other motor in the competition area, even if it’s only for weight or decoration; even if it’s in a box, off the field.
- Example 2: If your robot has two motors, but you have multiple attachments to motorize, you must design a way to switch the 3rd motor from one attachment to the next.
- LEGO wires and converter cables are allowed as needed.
- Spare/alternate electrical parts are allowed in the pit area.
- Computers are not allowed in the competition area.
- Objects functioning as remote controls are not allowed anywhere.
- Marker may be used for owner identification in hidden areas only.
- Paint, tape, glue, oil, etc. are not allowed.
- Stickers are not allowed except LEGO stickers applied per LEGO instructions.
- You are not allowed to use more than one robot in a single match, but it is okay to use a different robot in a different match.
- If a robot is in violation - of this rule or the SOFTWARE rule - and cannot be corrected, the decision about exactly what to do rests with the head officials at the tournament, but that robot may not win awards.
3 - SOFTWARE
- Your robot must be programmed using LEGO MINDSTORMS, RoboLab, or NXT software (any release).
- Patches, add-ons, and new versions of the allowable software from the manufacturers (LEGO and National Instruments) are allowed.
- Text-based and/or “outside” software is not allowed.
- The point of this rule is the same as that of the MATERIALS rule: Since we can’t ensure equal coaching for all teams, we at least limit this unfairness by capping the power of the tools.

4 - DOWNLOADING AND WIRELESS SIGNALS
- Downloading programs to robots must take place in the pits only - never in the competition area.
- Teams downloading to an RCX robot must make sure the process is shielded, that there are no other RCX robots in range, and robots should be turned off when not in use.
- Teams downloading to an NXT robot must do so by cable. Bluetooth must be switched off at all times.

5 - FIELD
- The field is where the Robot Game takes place.
- It consists of a field mat, on a table, with mission models arranged on top.
- The field mat and the LEGO pieces for building the mission models are part of your Field Setup Kit.
- The instructions for building the mission models are on a CD which comes in the same box as the LEGO pieces.
- All other field setup instructions are on the Field Setup page.

6 - BASE
- Base is a VOLUME. Base is not just an area on the mat.
- Base is an imaginary box formed by vertical walls that rise from the perimeter of the Base area, including the inside surface of the border walls, and by an invisible ceiling 16 in (40 cm) high.
- Base is where your robot is prepared and handled.
- Base is where your robot always starts and restarts from.
- Base is often a scoring target.

7 - VARIABILITY
- As you build and program, keep in mind that our suppliers, donors, and volunteers make every effort to ensure that all fields are correct and identical, but you should always expect some variability, such as:
  - flaws in the border walls.
  - variety in lighting conditions.
  - texture/bumps under the mat.
- waviness in the mat itself - at many tournaments, it is impossible for the mats to be rolled out in time to lose their waviness. Location and severity of waviness varies. You are being warned here. Consider this while designing.

- Two important building techniques you can use to limit the effects of variability are:
  - Avoid steering systems that involve something sliding on the mat.
  - Cover your light sensors from surrounding light.

- Questions about conditions at a particular tournament should be asked of that event’s head officials.

8 - MISSION

- A mission is defined as a result or action worth points.
- You decide the order you want to try missions in, and you don’t have to try them all.
- You’re allowed to re-try them, but often it’s not possible.

9 - MATCH

- At a tournament, two Robot Game fields are joined back to back, and you are paired opposite another team to compete in a match. Here’s the process:
  - You arrive at the competition table and have at least one minute to prepare your robot.
  - The match starts and you start your robot. Once started, the robot is now “active” and is understood to be working on missions.
  - The robot may get a lot done, or a little, but eventually you are likely to need/want to handle it. For example, it may become stuck, or you may want to add an attachment, or unload some cargo.
  - As soon as you touch it, no matter where it is or what it was doing, it is now “inactive” and must be carried to Base if it’s not already there.
  - While the robot is in Base, you prepare it for its next active period, and restart it.
  - These steps repeat (often with music, an announcer, and cheering in the background!), until the 2-1/2 minute match timer sounds (the timer never pauses during a match).

- There are at least three matches at each tournament, and each one is a fresh chance for you to get your best score.
- No match has anything to do with another, and only your best score counts specifically toward the Robot Performance Award.
- If it is known in advance that a team will not have another team opposite them, a volunteer or “house” team should substitute. If you compete against an empty table, you get the points for any interactive missions.

10 - ROUND

- The process of cycling all teams through one match each is called a round.
- Tournaments run at least three rounds.
• Between your match in one round and the next, you usually have time to go to the pit area and work on your robot and its programs as needed, but this time may be limited, depending on the schedule of other proceedings.

11 - ROBOT
• Your robot is defined as the main body containing the NXT (or RCX) controller and anything that does not fall off when the main body is picked up, turned over (or flipped any way), and/or shaken.

12 - ATTACHMENTS
• Attachments are defined as parts of your robot that are designed to be added and/or removed.

13 - STRATEGIC OBJECTS
• Strategic objects are defined as team-supplied objects which you or your robot may use as tools or aids.
• You may touch or use strategic objects *only in Base, but your robot may touch or use them anywhere.
  * Example: If you’re using a device to aim your robot, you need to either pull the device away or let go of it before your robot is allowed to start.

14 - MISSION MODELS
• Mission models are defined as the objects that are already on a competition field when you walk up to it.
• You may not bring duplicate mission models to the table if they could confuse scoring.
• You may not take mission models apart, even temporarily.
• Mission models must be separated from your team-supplied objects quickly after the match.
• Be very careful not to leave the competition area with that field’s mission models.

15 - HOUSEKEEPING
• After the referee (the “ref”) inspects everything you’ve brought to the competition area, you may store it all in a box on a stand where you can get to it quickly while operating your robot.
• Team members other than the two at the table are not allowed to hold anything unless approved by the ref.
• Nothing is allowed on the floor unless approved by the ref.
• Mission models always need to stay in view of the ref.
• In rare situations of crowding at Base, the ref allows you to store objects on the table away from Base, but only if it is obvious their placement is purely for storage.
16 - ROBOT PREPARATION AND HANDLING
• Before the match, and whenever else your robot is inactive, you are allowed to handle it and prepare it by hand for its next active period.
• Typical preparations include repairs, switching attachments, loading and unloading objects, selecting programs, resetting features, and manipulating, arranging, and aiming the robot and any objects it will be moving or using.
• This work should be done in or near Base to avoid messing up the field.
• Once your robot and its objects are ready to start, the last thing you must do is to let go of it all.

17 - MUSCLE ACTIONS
• You may not cause things to extend, leave, or be placed out of Base, even partially, except as described in the START PROCEDURE and HOUSEKEEPING RULES.
• You may not move or “adjust” anything outside of Base.
• In Base, you are allowed to manipulate any objects that have reached Base, even to produce scoring conditions.
• You may place objects completely in Base for an active robot to interact with, but only if you have obviously let go of them before your robot touches them.
• As soon as your robot or anything it’s strategically controlling reaches Base, you may take it all (robot plus objects) into Base.
• Dropping something on your active robot is treated as an active robot touch.

18 - START POSITION
• For all starts beginning and during the match, every bit of your robot including its attachments and any objects it is about to move or use must fit completely in Base.
• Nothing is allowed to be poking through the imaginary box.
• Your robot is allowed, but not required, to touch objects it is about to move or use.
• You must not be touching your robot or anything it is about to move or use.
• Everything must be motionless.

19 - START PROCEDURE
• When it’s obvious to the ref that starting position is correct…
  o For the start of the match…
    ▪ The ref asks you if you’re ready, then signal your readiness to the announcer.
    ▪ As the countdown starts, you reach in with one hand, ready to either touch a button, or signal a sensor, to start or resume your robot’s program.
    ▪ When you hear the sound, you start your robot.
For all other starts (restarts)…

• There’s no countdown. The ref sees that you’re ready, and you start your robot.

• You may not handle your robot, or anything it’s about to move or use, during or after the countdown. If you do, the ref has you restart. The point of this rule is to ensure that your only influence on your robot is to get its program running. When it’s obvious to the ref that
• The exact time to start is at the beginning of the last word in the countdown, such as “Ready, set, GO!”
• If a different signal is used, the start is at the beginning of that signal.

20 - ACTIVE ROBOT <> INACTIVE ROBOT

• At the moment your robot is started, it becomes “active” and remains so until the next time you touch it, or anything it is strategically controlling.
• At the moment of that touch, the robot becomes inactive again, and must be carried to Base unless it’s already there. There may be additional **consequences.
• The inactive robot in Base may then be handled/prepared and restarted.

21 - **ACTIVE ROBOT TOUCHED COMPLETELY OUT OF BASE
If the robot and every object in its strategic control are completely out of Base…

• a “touch penalty object” is taken out of play if one is available, as described in the missions.
• objects that were with the robot the last time it left Base go to Base, for scoring or continued use.
• objects that were not with the robot the last time it left Base are taken out of play (may not be used again).

22 - ACTIVE ROBOT TOUCHED IN BASE
If the robot or any objects in its strategic control are at least partially in Base…

• there is no “touch penalty.”
• those objects are placed in Base for scoring or continued use.

23 - TETHERS/LEASHES
If the only part of your robot in Base at the time of an active robot touch is a cord, hose, wire, tube, chain or string, the robot is treated as if it were completely out of Base.

24 - LOSS OF CONTACT

• If an untouched robot loses contact with an object, that object stays where it is unless/until the robot regains contact with it. Such objects may not be recovered by hand.
• For exceptions, see the STRAY OBJECTS and ROBOT DAMAGE rules.

25 - STRAY OBJECTS
• Objects *caused by any robot* to be in a non-scoring position may be taken out of play by the ref upon request or by you if the ref is too far away to act in time. Objects “taken out of play” may not be used again.
• Objects in their original “setup” positions are never considered stray.
• Objects in scoring position are never considered stray.

**26 - ROBOT DAMAGE**

• At any time, you may recover robot parts that come off as a result of obviously unintentional damage.
• You may do this by hand or request help from the ref.
• Parts planned or designed to come off are strategic objects, and are covered under the LOSS OF CONTACT rule.

**27 - FIELD DAMAGE**

• Field damage is defined as:
  o whenever a mission model is broken or malfunctioning.
  o whenever a Dual Lock connection is separated.
  o any change to your field that is not caused by your robot.
  o any change to your field that is caused by an inactive robot.
  o any change to your field that violates a rule or Game Q&A ruling.
• When field damage occurs, the ref is placed in the difficult position of having to recall the field’s condition right before the damage, and restore it to that condition.
• Field damage too severe to reverse is left as is or swept away.
• If scoring is in question after field damage that was mostly due to faulty model design, construction, or setup, you get the points.
• If scoring is in question after field damage that was mostly due to your robot acting with too much force and/or not enough accuracy (messing up), you are more likely to get the a “benefit of the doubt” call, along with a warning, in Round 1 than in later rounds.
• It is not field damage and the field does not get restored when your robot simply does things you don’t like.

**28 - INTERFERENCE**

• Your robot is not allowed to have any effect on the other team’s robot, field, or strategy, except by directly meeting the scoring requirements of missions in areas that are shared between the two sides by design of the Robot Game.
• There is always at least one mission where you and the opposing team are set up to interact in some way, either competitively or cooperatively.
• As a matter of luck, that team may be able to outperform you on that mission or may fail to cooperate with you there. This is not considered interference.
29 - FINAL FIELD CONDITION

- To minimize controversy about what happened during a match, THE SCORE IS DETERMINED AT THE END OF THE MATCH, BY THE SNAPSHOT CONDITION OF THE FIELD AT THAT EXACT TIME ONLY.
- This means that points are not given for results your robot gets but then trashes before the match ends.
- This is also why actions that are not allowed (rule violations) are either stopped or reversed as they happen.

30 - IN

- A is “in” area B if any bit of A is over area B.
- Barely “in” is considered “in” unless the word “completely” is used.
- Direct contact (touching) is not part of the definition of “in.”
- Objects in a container are ruled on individually, and independent of their container.
- Exception: Objects returning to Base with your robot are considered IN as soon as the robot reaches Base.

31 - TOUCHING

- A is “touching” B only if A is making direct contact with B.
- Any amount of direct contact counts as touching.

32 - BENEFIT OF THE DOUBT

- You get the benefit of the doubt when:
  - a split-second or the thickness of a (thin) line is a factor.
  - a situation could “go either way” due to confusing, conflicting, or missing information.
  - anyone other than the challenge designer claims to know the “intent” of a requirement or constraint.
- If you (kids, not coach) disagree with the ref and can respectfully raise sufficient doubt in his/her mind, the ref meets with the head ref, and the resultant decision is final.
- This rule is not an order for the refs to be lenient, but it is a license for them to make judgment calls in your favor when it's reasonable to do so.

33 - PRECEDENCE

- When there is conflict between pictures/videos and text, the text takes precedence.
- When there is conflict between a mission and a rule, the mission takes precedence, but the current Game Q&A page on the web takes overall precedence. MAKE SURE TO CHECK BACK THERE OFTEN.
- The head ref is not obligated to consider calls made at previous tournaments unless those calls have been added to the latest Game Q&A.

34 - AFTER THE MATCH
• No one is allowed to touch anything on the field yet…
• The ref first needs time to record the condition of the field, and come to agreement with you (kids) about what points were scored or missed and why (and to be sure you’re not walking away with any of that field’s mission models!). Data is marked on a sheet which you initial.
• The scores are tallied by computer, with ties being broken using 2nd and then 3rd highest scores.

CHALLENGE SUPPORT
• Official Robot Game support is available through flltech@usfirst.org (usual response in 1-2 business days).
• Before you e-mail, be sure you’ve read the Field Setup, the Missions, these Rules, and the updated Game Q&A, since flltech refers to these and only these, exactly as you and the refs are supposed to.
• E-mail replies you get are only to guide you. Refs are not obligated to read them.
• When e-mailing, please state your role on the team (member, coach, parent, mentor).
• flltech can help you construct rule-based paths of reason for assessing special strategies or situations.
• flltech may share the answer to your question on the Game Q&A if the question is popular, reveals missing or confusing text, reveals a flaw in the game, reveals an unresolvable conflict, or is amazing or entertaining.
• No new Game Q&A entries are posted after 3PM (eastern U.S.) on Fridays.
• flltech does not answer questions about building or programming the robot (that’s your challenge).
• flltech cannot support LEGO product (RIS, RoboLab, and NXT). Instead call 1-866-349-5346.
• flltech does not respond to questions posted in the discussion forum. The forum is great for sharing ideas and getting tips from other teams, but it is NOT AN OFFICIAL SOURCE OF ANSWERS about anything.

COACHES’ MEETING
• If a question does come up right before the tournament, your last chance to ask it is at the “Coaches’ Meeting” (if there is one) the morning of the tournament.
• The head ref and coaches meet to identify and settle any differences before any matches start.
• For the rest of the day, the ref’s calls are final when you leave the table.
SUMMARY OF SIGNIFICANT CONTENT CHANGES FOR 2009

A - The restriction against attaching things to mission models has been removed.
B - The robot and everything it has can now be pulled into Base as soon as any of it reaches Base.
C - Stray objects must now be taken off the table if they’re going to be moved at all. Shifting is not allowed.
D - A tethering rule allows tethering while preventing teams from using it to avoid a touch penalty.
E - The definition of ON has been removed.
Appendix M

FLL and CEENBoT Program
Special thanks to the Strategic Air and Space Museum for hosting this event and for their ongoing support!

Saturday, January 30, 2010
Strategic Air and Space Museum
Ashland, Nebraska
Welcome to the Nebraska Robotics Expo!

The Expo represents a collaborative effort between the SPIRIT Project, the GEAR-Tech-21 4-H Youth Development project, and FIRST® LEGO® League to create an outstanding robotics competition for about 400 of our local and greater Nebraska area youth. As you cheer on our future scientists and engineers, we encourage you to visit the CEENBoT™ Showcase, FIRST LEGO League events, sponsor booths, and museum exhibits.

Schedule of Events

7:30  Team Check-in Opens
8:30  Opening Ceremony (atrium)
      Keynote address by Governor Heineman
9:15  FLL Competition begins
9:30  CEENBoT™ Showcase events begin
11:30 FLL Lunch Break
12:15 CEENBoT™ Showcase Lunch Break
12:15 FLL Competition resumes
1:30  CEENBoT™ Showcase resumes
4:00  Awards Ceremonies (Hangars A and B)
5:00  Museum Closes

See the FLL and Showcase Schedules for more details.

More to See and Do

- CEENBoT™ Showcase Student Presentation (Conference Room)
- Help judge Creativity Bot entries (Hangar A)
- Robotics displays and hands-on educational exhibits (Mezzanine-Hangar A)
- Sponsor booths with educational materials (Atrium)
- Presentations by Lockheed Martin (Conference Room)
- The Museum’s hands-on Leonardo da Vinci exhibit

FLL Core Values
- We are a team.
- We do the work to find solutions with guidance from our coaches and mentors.
- We honor the spirit of friendly competition.
- What we discover is more important than what we win.
- We share our experiences with others.
- We display gracious professionalism in everything we do.
- We have fun.

CEENBoT™ Showcase Participating Schools

Lothrop
Parkview Heights
Willa Cather
Westside
Humphrey St. Francis
Neihigh-Oakdale
Hartman
Prairie Lane
Omaha North

St. Mary’s
Mary Our Queen
Omaha Benson
La Vista Jr. High
Beadle
Loveland
Norfolk Middle
Tara Heights
Trinity Christian

FIRST® LEGO® League Teams

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<tr>
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<th>Team Name</th>
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<td>Fighting Falcons</td>
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<td>Jaguars from Nebraska Science and Technology Center</td>
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<td>The Flying Pigs from Nebraska Science &amp; Technology Center</td>
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<td>2</td>
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<td>17</td>
<td>Seeman and Harper Theaters</td>
<td>Sponsor Presentations</td>
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About FIRST®
FIRST® (For Inspiration and Recognition of Science and Technology) was founded in 1989 by inventor Dean Kamen to inspire young people's interest and participation in science and technology. Based in Manchester, NH, FIRST is a 501(c)(3) not-for-profit public charity. FIRST is supported by a strong network of sponsors and volunteers.

FIRST provides the FIRST Robotics Competition (FRC) and FIRST Tech Challenge (FTC) for students in Grades 9-12 (ages 14-18), the FIRST LEGO® League (FLL) for Grades 4-8 (ages 9 to 14), and the Junior FIRST LEGO League (Jr. FLL) for Grades K-3 (ages 6 to 9). For more information, visit www.usfirst.org. FIRST and its logos are registered trademarks of US FIRST.

About the LEGO® Group
The LEGO Group, a privately-held, family-owned company based in Billund, Denmark, is one of the world's leading manufacturers of high-quality, creative educational play materials for children. The company is committed to the development of children's creative and imaginative abilities, and its employees are guided by the motto adopted in the 1950s by founder Ole Kirk Christiansen: "Only the best is good enough." For more information, visit www.LEGO.com. LEGO, MINDSTORMS® and their respective logos are registered trademarks of the LEGO Group.

FIRST® LEGO® League
Children are immersed in real-world science and technology challenges as part of the FIRST® LEGO® League Program. Teams build LEGO®-based robots and develop research projects. Through their participation, children develop valuable life skills and discover exciting career possibilities while learning that they can make a positive contribution to society.

Children ages 9 to 14 get to:
- Strategize, design, build, program and test a robot using LEGO® MINDSTORMS® technology
- Create innovative solutions for challenges facing today's scientists as part of their research project
- Apply real-world math and science concepts
- Develop employment and life skills including critical thinking, time management, collaboration, and communication while becoming more self-confident
- Engage in team activities guided by FLL Core Values
- Become involved in their local and global community
- Choose to participate in official tournaments and local events coordinated by their community
- Qualify for an invitation to World Festival

FLL in Nebraska
The FLL Planning Committee gives special thanks to Time Warner Cable for sponsoring FIRST LEGO League, including awards, audiovisual equipment and operations, volunteer hospitality, and volunteers.

We also thank all judges, referees, coaches, and all adult volunteers. You make FLL possible for Nebraska!

About The SPIRIT Program
The SPIRIT Program, which stands for the Silicon Prairie Initiative for Robotics in Information Technology, is funded by the National Science Foundation and is striving to help teachers use educational robotics to teach important science, technology, engineering, and mathematics concepts. The SPIRIT program combines the technical expertise of engineers at the University of Nebraska–Lincoln Computer and Electronics Engineering Department with the educational expertise of professors in the College of Education at the University of Nebraska at Omaha.

The collaboration is developing a national educational robotics curriculum for middle schools. The SPIRIT projects use a new robot, called the CEENBoTM™, which is being designed for the NSF, and is a flexible and realistic engineering platform.

As of January 2010, nearly 200 teachers have been trained in NSF extended workshops and graduate courses, and more than 120 Internet-based lessons have been created. Teacher surveys and student assessments have documented teacher significant growth in problem-based learning, robotics, electronics, and engineering design.

The SPIRIT Showcase
The Nebraska Robotics Expo marks the second season for the SPIRIT Showcase. The showcase event was held last March at the Peter Kiewit Institute, on the South Campus of UNO. With 36 teams competing in this year’s competition compared to last year’s 24 teams, the Showcase is showing a steady and growing interest.

Educators are encouraged to check out the extensive SPIRIT website at the following URL and to join us:

http://www.ceen.unomaha.edu/TekBots/SPRIT2
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<th>School</th>
<th>Team Category</th>
<th>Team Name</th>
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<th>TekBot Ball Arena</th>
<th>CEENBot Road</th>
<th>CEENBot Ball Arena</th>
<th>Documentation Session</th>
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<th>Student Presentations</th>
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<td>Elem</td>
<td>ABLE</td>
<td>1:00 PM</td>
<td>9:30:00 AM</td>
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<td>1:00:00 PM</td>
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