Adolescent Leadership Development through Participation in a Robotics Design Challenge Experience

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Doctor of Education

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Adolescent Leadership Development through

Participation in a Robotics Design Challenge Experience

The undersigned, appointed by the dean of the Graduate School,

have examined the dissertation entitled

ADOLESCENT LEADERSHIP DEVELOPMENT THROUGH

PARTICIPATION IN A ROBOTICS DESIGN CHALLENGE EXPERIENCE

presented by

David Allan Doering

a candidate for the degree of doctor of education

and hereby certify that, in their opinion, it is worthy of acceptance.

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Table of Contents

List of Illustrations

Table Page

Abstract

This research study explored the adolescent leadership development experiences within teams participating in the Robotics Design Challenge sponsored by the University of Missouri Engineering Department. Since the design challenge was not a leadership development program, this research explored whether or not leadership development occurred. The first research question was whether leadership development experiences emerged. The second question took a constructivist and situational view of how the adolescents experience leadership development. The third research question examined roles of the adult mentors that fostered leadership development. The final question explored the adult-mentors' descriptions of the resulting leadership development experiences. Two sites, seven teams, and twenty-eight adolescents, ages 10 through 12, were observed during team meetings and participated in focus groups. The environment included authentic opportunity, mentor access, amount of challenge, variety of tasks, and quality and acceptance of feedback. The adolescents exhibited leadership traits and behaviors such as confidence, knowledge, teamwork, and problem solving. The adult-mentors provided valuable structure and feedback. The adults reflected on the level of difficulty as being important to developing leadership and described several adolescents who exhibited leadership traits and behaviors. The robotics design challenge provided an environment in which adolescents could develop leadership skills. Providing similar opportunities to additional adolescents and incorporating leadership development into those activities could be beneficial to the overall development of the adolescents.

Adolescent Leadership Development through

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Introduction

This research study explored the adolescent leadership development experiences within teams participating in the Robotics Design Challenge sponsored by the University of Missouri Engineering Department. Although not designed as a youth leadership development program, the implementation of Robotics Design Challenge teams includes aspects similar to leadership development programs: challenging problems, goal setting, teamwork, mentoring, and experiential learning.

Robotics Design Challenge is an event for youth, grades K through 8. The youth learn about, design, build, and program a LEGO robot to accomplish a given challenge. The stated goal of the event "is to introduce STEM (Science, Technology, Engineering, and Math) skills at an early age and to motivate them to pursue science and engineering careers" (9th Annual Robotics Design Challenge).

A typical challenge is to have the LEGO robot equipped with various sensors to follow a path with constraints such as time and barriers. Prior to a challenge-event-day, teams of 2 to 4 youth typically have 10 to 20 meetings to assemble to learn, build, and practice. On the day of the challenge event, teams earn points for their challenge course attempt and a programming judge interview.

Points earned during the challenge-course attempt are sorted into three categories: course objectives, technique, and other. Course objective points include passing over checkpoint lines, stopping in pause areas, and staying within the final pause area. Technique points are gained for each sensor used to complete the course. Other points

can be earned for creativity in design and implementation and for playing a sound at the starting line or finish area (2014 MU Annual Robotics Challenge).

Teams "meet with a panel of judges to discuss their approach to programming the robot to complete the challenge" (2014 MU Annual Robotics Challenge). Points can be earned in the following areas: explanation of robot's operation through the course, explanation of course navigation, rationale for the sensors used, discussion of problems encountered, and discussion of possible improvements (2014 MU Annual Robotics Challenge).

The Robotics Design Challenge participants experience an environment different from a typical day. Working in teams on challenging problems, the students possess the opportunity to learn and practice traits and behaviors of leaders.

Statement of the Problem

Leadership development of adults is well studied and has led to a huge industry designed to supersede years of individual development, precursors, experiences, self-management, and demonstrated behaviors. Organizations claim to have programs and systems to foster leadership development in adolescents, but research regarding adolescent leadership development is lacking and inconclusive regarding effective implementation (Murphy & Reichard, 2011; Whitehead, 2009).

Adolescent development research indicates that youth aged 9 through 14 develop many traits and behaviors while developing their sense of self in addition to experiencing a wide array of social, physical, cognitive, attitudinal, and emotional changes. Adolescents exhibit leadership behaviors and fill leadership roles, but they do not always internalize traits and behaviors that lead to successful leadership experiences. Extra-

curricular well-designed opportunities may help develop adolescents' sense of self and leadership abilities in a positive and social environment (Haensly, Lupkowski, & Edlind, 1986; Murphy, 2011; Whitehead, 2009).

Research is needed to identify best practices in regards to implementing youth leadership development programs. This adolescent leadership study will add to literature regarding adolescence and adolescent leadership development.

Purpose of the Study

The purpose of this phenomenological study was to explore the leadership development experiences of adolescents participating in the Robotics Design Challenge sponsored by the University of Missouri Engineering Department. Leadership development includes experiences which promote attainment and growth of leadership traits and behaviors.

Research Questions

This study utilized qualitative research principles guided by constructivist theory allowing for emergent design. Emergent design permitted concepts not specifically detailed in this proposal to emerge as constructs and theory. Creswell (2007) described the impact of qualitative research by writing, "sometimes the research questions change in the middle of the study to reflect better the types of questions needed to understand the research problem" (p. 19).

The initial research proposal included five research questions edited and reduced to four questions as follows. Question two's verb has been edited from describe to experience, to better reflect the participant's developmental readiness and difficulty verbalizing their experiences. Question five was "What factors lead to similarities and

differences between leadership development experiences described by separate Robotics Design Challenge teams' adolescents?" The two sites and six teams experienced very similar environments with no substantial differences. The "factors" within the intent of this original question did lead to data for the other four questions and continued to be included in this study, just not as a separate question based on youth descriptions.

The following research questions guided the methodology and design.

Adolescent perspective.

1. What leadership development experiences emerge for adolescent participants in the Robotics Design Challenge?
2. How do adolescent participants experience leadership development in the Robotics Design Challenge?

Adult-mentor perspective.

3. What role do adult-mentor participants play in fostering adolescent leadership development opportunities in the Robotics Design Challenge?
4. How do adult-mentor participants describe leadership development experiences in the Robotics Design Challenge?

Conceptual Framework

Research related to constructivism, subjective leadership, and situational leadership guided the methodology and procedures of this study. One common thread throughout these concepts is that experiences of individuals receive greater emphasis than the outcomes of the group.

Constructivism is a theory of knowledge based primarily on Jean Piaget's mid 20th century research and beliefs that knowledge and meaning are generated from an

individual's experiences and ideas. Constructivism led people to reconsider pure scientific views of learning and leadership and to consider individual differences. Robert Starrat wrote about democratic (shared) leadership and the potential benefits of applying constructivist theory to democratic leadership. Starrat described constructivism as "a continuous cycle of the construction of knowledge, the self, the other, the world, of the deconstruction of knowledge, the self, the other, the world, and of the reconstruction of knowledge, the self, the other, the world" (2001, p. 344). Success in democratic leadership may be improved by deconstructing and reconstructing each individual and each situation. Each individual experiences events differently constructing their own interpretation and response. Leaders and organizations may benefit from not only understanding individual constructs but encouraging others to be leaders within the organization.

Subjective leadership and management based models surfaced in the 1970s and 1980s rising in importance from Thomas Barr Greenfield's vocal opposition to established theories which focused on science, systems, and the organization. Greenfield's rejection of scientific management of people led some to view employees as needing to be led, not managed. Hermes wrote, "subjective theories presuppose that human beings are autonomous and reflective beings, actively constructing the world around them" (Hermes, 1999, p. 198). Bolman and Deal (as printed in Bush, 2003) wrote "the same events can have very different meanings for different people because of differences in the schema that they use to interpret their experience" (p. 115). Subjective models emphasize the individual instead of the organization. Effective leaders manage and lead individuals not the company, the department, nor the project.

Leadership activity and the interaction between leaders, followers, and the situation is more important than who is the leader (Spillane, Halverson, and Diamond, 2004). Grint described how one individual may demonstrate different leadership behavior based on the situation: critical, tame, or wicked (2005). Further, the success of a leader's decisions lies in how well the leader is able to convince followers. Situational leadership theory leads us to examine each leadership behavior and decision within the context of the event and the individuals involved (Bush, 2003; Spillane, Halverson, and Diamond, 2004).

The concepts of constructivism, subjective leadership theory, and situational leadership theory guided this study. Each event, individual, trait, and behavior was examined as a separate experience. Common trends and theories developed, but it was important to examine the data without preconceived notions of why something happened.

Definitions and Terms

Constructivism is a belief that individuals construct different meanings of information and events based on the individual's knowledge, beliefs, and experiences. The adolescents in the study had very similar experiences throughout the program, but each person constructed his or her own meanings of the challenge event experience.

Subjective leadership is a theory which emphasizes the individual over the organization. The adolescents in the study did not nor were they expected to lead using certain leadership models. The researcher used subjective leadership concepts to focus on trying to understand the meaning individuals might be placing on the shared events.

Situational leadership is a theory which not only seeks to understand the meaning individuals place on events, but that the leader attempts to view events from multiple

perspectives and respond appropriately. The adolescents in the program did not appear to analyze events from the perspectives of others, but they did behave differently depending on the situation. For example, during the team meeting observations that occurred just days before the challenge event, there was much more activity and several youth demonstrated leadership traits and behaviors that were not observed during previous team meetings.

Confidence is a feeling of self-assurance arising from one's appreciation of one's own abilities or qualities. Within the study, adolescents showed confidence when they volunteered answers to the inquiry of others (even when they did not know the answer). They also demonstrated confidence when speaking up and/or becoming more active within their teams.

Knowledge includes facts, information, and skills acquired by a person through experience or education. Only three of the youth had previous experience with the content and skills found in this challenge. Obtaining knowledge within the program occurred in lecture and inquiry formats, but mostly through practicing hands-on manipulation of the hardware and software.

Teamwork is the combined action of a group of people, especially when effective and efficient. Working as an individual or as a group are different from the expectations of the term teamwork. Observing the teams, there was a significant amount of individual and group work. Teamwork involved the collaboration of multiple people accomplishing more together than they could apart.

Problem-solving involves finding solutions to difficult or complex issues. Due to the nature of this event, there was a lot of trial-and-error-approach to solving the

challenge. For problem solving to fit into leadership there must be a higher-level process involved in finding the solution including collaboration, brainstorming, and analyzing.

Challenge within the context of this research project is important because success is dependent on the team. The program was designed to be difficult and too much for an individual to complete. The participants relied on others on the team to complete all of the assigned tasks.

Variety of the tasks within the Robotics Design Challenge program included teamwork and collaboration, sensor selection and implementation, robot design and building, and software programming. In addition, additional roles developed during the different stages of the process. Individuals may naturally exhibit leader traits and behaviors when they are confident in their abilities in a certain area, but it is important in developing leadership for an individual to experience different types of tasks (Yukl, 2010).

Providing feedback such as good observations and recommendations for improvement are important to leadership development especially for adolescents. Feedback can be informal and spontaneous as well as formal. Within the Robotics Design Challenge program feedback from team members and adults provides the youth validation as well as guidance for improvement.

Adolescence is usually considered ages 10 through 15. During these years people experience significant growth in many developmental areas including abstract thinking; attention; memory; processing speed; organization; metacognition; and social, identity, and psychosocial development. Research on adolescents discusses the concept of developmental readiness, which is whether a person is able to process experiences in

"grown-up" ways (Murphy and Reichard, 2011). Two youth may have the exact same experience, but they may process the events differently – corresponding to subjective leadership models.

Bandura defined self-efficacy as the belief "individuals have about their ability to achieve specific goals" (as cited in Murphy and Reichard, 2011, p. 191). Individuals exhibiting leadership often have a high level of self-efficacy related to the situation. At some level the adolescent participants either believe they can or cannot complete the challenges faced in the Robotics Design Challenge program. In addition, each individual has a belief about whether he or she can be a leader. It might be expected that the adolescents exhibiting the most leadership have more confidence in his/her ability to meet the goals and lead their peers.

Delimitations

The Robotics Design Challenge teams located within a small socioeconomic and geographic region bound this qualitative study. This study did not evaluate Robotics Design Challenge nor the individual teams, leadership traits and behaviors, adolescent psychology, nor teamwork concepts. Previous research, concepts, and theories informed this study, but the intent is not to revisit those items. This study focused on potential leadership development within the Robotics Design Challenge teams. As the study progressed, additional research on adolescent development and recent conceptual models helped give meaning to the observed events.

Limitations

Leadership, leadership development, and adolescent development involve many concepts and theories that could not be fully accounted for in this research project. The

three-month period provided adequate time to observe leadership development within the context of this study, but did not provide enough time to factor in the many additional concepts and theories that may also apply to the situation.

Triangulating data strengthened validity. One significant portion of data came from the focus-group discussions of adolescents who may not be able to fully reflect on events and communicate their responses completely. The design of the focus group received extra planning to ensure that the time was valuable to the researcher while still being a positive experience for the adolescents. Despite the extra care taken, many of the adolescent responses were very brief and were similar to one another, yet is some ways the data reflected the previously observed traits and behaviors.

Significance of the Study

Young adolescents may not be developmentally ready to develop leadership. Most related research addresses older adolescents into adulthood specifically high school and college aged participants. Developing leadership skills can lead to many positives for the individual through adolescence and adulthood. Extracurricular programs designed for adolescents provide leadership opportunities they would not otherwise receive (Mitra, 2005; Murphy & Reichard, 2011; Striffolino & Saunders, 1989).

Leadership and team opportunities during adolescence affect the individual's leadership behaviors and traits as an adult (Murphy, 2011; Schneider, Paul, White, & Holcombe, 1999). Research on adolescent development exists including Piaget and Erikson, but there has not been much focus on leadership (Murphy, 2011; Murphy & Johnson, 2011; Peterson, 1988; Steinberg & Morris, 2001). Research on adult-leadership development exists, but there are varying opinions regarding successful adult-leadership

development (Bass, 1989; Blake & Mouton, 1985; Connaughton, Lawrence, & Ruben, 2003; Greenleaf, 1977; Kouzes & Posner, 2008; Murphy, 2011; Phipps, 2010; Whitehead, 2009; Yukl, 2010). "More research is needed to examine how existing theories of adult leadership may be transferred, and perhaps modified, to understand the processes of leadership at each developmental stage" (Murphy, 2011, p. 19). MacNeil (2006) described a significant amount of research regarding traits and behaviors, but argued that youth leadership development research is lacking investigations into "opportunities for developing and practicing voice, influence, and decision making" (p. 40). This research will look for leadership development in a "real-life" activity designed for adolescents.

Student leadership development research primarily focuses on college and high school students and programs (Connaughton, Lawrence, & Ruben, 2003; Cooper, Healey, & Simpson, 1994; Kouzes & Posner, 2008; Murphy & Reichard, 2011; Roberts & Ullom, 1989; Schneider, Paul, White, & Holcombe, 1999). With a focus on adolescents, this study may encourage additional research into developing leadership skills in younger people.

Adolescent leadership development may require techniques different from adult leadership training due to participants at various developmental stages, yet potentially "easier" to change. Leadership development of adolescents may require adjustments compared to older participants including narrower focus, additional mentoring, or feedback that is more frequent. Factors leading to successful adolescent leadership development have not been fully researched. Long-term advantages of participating in adolescent leadership development need further investigation.

Future research may also be conducted on what pre-existing traits, backgrounds, and abilities do successful-in-the-program students have in common. Selecting the best possible students to participate in such programs may lead to more success for all involved. In addition, other students may benefit from alternative development opportunities or additional pre-training. Would adolescents (and the Robotics Design Challenge) benefit from activities meant to develop teamwork or leadership?

Future research may focus on the effect implementation strategies and levels of support have on the program and student's success. Can a program be designed that will be successful regardless of the quality of the implementation of the program?

Chapter two reviews existing literature. Trait and behavior leadership lays the foundation for the observations made by the researcher during this study. Subjective and situational leadership theories provide a foundation for knowing that leadership is not only traits and behaviors, but other factors are important in the actions of leaders and whether those actions can be categorized as a success or not. Leadership development concepts laid the foundation for exploring whether the events of this study provided opportunities of the development of leadership. Adolescents bring with them another set of developmental considerations discussed within the context of adolescent leadership development. Finally one must consider the role adults play in the development of adolescent leadership.

Review of Literature

Do people develop leadership skills or are leaders born with the necessary traits and behaviors? This nature versus nurture question served the focus of leadership research for many years with mixed results. Two individuals participating in the same leadership development program can have very different results. Two individuals with very similar leadership skill sets can have very different results during implementation. Possibly the most frustrating situation is a leader, who has been very successful in one situation, may struggle when placed in a new situation.

This study seeks to explore the leadership development experiences of adolescents participating in the Robotics Design Challenge. Robotics Design Challenge offers an environment similar to formal experiential leadership development opportunities providing an excellent situation in which to examine adolescents and how leadership is manifested in their interactions. Leadership development opportunities for the youth abound throughout the Robotics Design Challenge experience.

This literature review provides the conceptual background to help identify the leadership opportunities and to understand the actions of the youth and adults involved. Individual adolescents and the adults will have diverse views of the leadership opportunities and how the adolescents exhibited leadership. In addition the actions of the adults may influence the opportunities available and the behavior of the youth.

To fully understand the potential leadership development occurring one must have an understanding of leadership, leadership theories, adolescence, and leadership development. This chapter will highlight major tenets of trait and behavioral, subjective,

and situational leadership models in addition to leadership development research focusing on adolescents.

Trait and Behavioral Leadership

Definitions of leadership vary among different researchers and continue to evolve. Karnes and Bean (1995) summarized adolescent responses to "what is leadership" as a multidimensional concept with a wide range of characteristics and behaviors. Day (2004) examined various definitions and chose to be very general in writing, "a process (not a position) that involves leaders, followers, and situations" (p. 840). Yukl (2010) described the wide range of definitions present in literature quoting 10 diverse attempts from various researchers. He attempted to account for many aspects by defining leadership as "the process of influencing others to understand and agree about what needs to be done and how to do it, and the process of facilitating individual and collective efforts to accomplish shared objectives" (2010, p. 8). What is it about a leader that influences and facilitates others?

Researchers identified various traits and behaviors they believe leaders possess (Bass, 1989; Blake & Mouton, 1985; Kouzes & Posner, 2008; Lord, DeVader, & Alliger, 1986; Posner & Brodsky, 1994; Stogdill, 1974; Yukl, 2010). Leadership development programs often focus on improving an individual's traits and behaviors (Bass, 1989; Connaughton, Lawrence, & Ruben, 2003; Kouzes & Posner, 2008; Lord, DeVader, & Alliger, 1986; Russell & Stone, 2002). Compiling years of literature from many researchers, Bass and Bass identified five categories of leadership trait competencies: (a) cognitive, (b) social competency, (c) emotional competency, (d) biophysical, (e) and character (2008).

Cognitive traits include intelligence, knowledge, and vision (Bass & Bass, 2008). Although having some level of intelligence is important, there does not appear to be a direct correlation so intelligence does not necessarily lead to increased ability to lead (Bass & Bass, 2008; Murphy, 2011). To lead, an individual needs to have sufficient knowledge to be self-confident, attempting to influence others based on their perceived higher-level of knowledge. Most researchers agree to the importance of the leader having a vision and being able to communicate the vision to others. Nirenberg identified vision as the first principle of leadership effectiveness (2004).

Social competency traits involve assertiveness, attractiveness, and empathy (Bass & Bass, 2008). Murphy (2011) identified assertiveness as a precursor attribute to leadership development. Many researchers believe attractiveness to be a factor in leadership, but just how much of a factor is unknown as views of attractiveness are very subjective. Culp and Cox (2002) stated that leaders must have empathy for individuals "outside their social group" (p. 48).

Emotional competency traits incorporate self-confidence, self-esteem, and self-efficacy (Bass & Bass, 2008). Confidence, esteem, and efficacy are frequently related to leadership, but the direct correlation is not as strong as our intuition would have us believe. Murphy (2011) categorizes these traits as self management writing, "leadership requires the ability to manage one's self in such a way as to succeed, especially in challenging situations" (p. 16).

Biophysical traits consist of stature and physical fitness (Bass & Bass, 2008). With rare exception leaders are portrayed in media, past and present, as being physically more developed than the average person. Similar to the emotional competency traits

above, humans may assume there is a relationship, but the actual correlation between biophysical traits and leadership may be relatively small.

Integrity, honesty, and discipline are examples of traits of character (Bass & Bass, 2008). Many leadership development programs, including Boy Scouts of America, Girl Scouts of America, and Youth Service America, approach situations from a moral and ethical lens. Service learning and authentic leadership research strives for leadership to be rooted in moral and ethical beliefs (Avolio & Hanna, 2008; Avolio & Vogelgesang, 2011; Whitehead, 2009).

People with leadership success may not have all of the traits listed above but generally have a noteworthy percentage of them. There does not appear to be one trait all leaders have nor one trait that assures effective leadership. Leadership theories acknowledge the importance of these traits, but now understand that there is more to being an effective leader (Day, 2004; Nirenberg, 2004).

There is more to leadership than a person having certain traits. How, when, and why a person demonstrates certain traits, behaviors, and attitudes goes a long way in determining success of the leader. Resulting from extensive research with young-adult student leaders, Kouzes and Posner acknowledge the traits above and categorize related behaviors into five themes: (a) Modeling the Way, (b) Inspiring a Shared Vision, (c) Challenging the Process, (d) Enabling Others to Act, and (e) Encouraging the Heart (2001, 2008).

Modeling the way involves setting high standards and living up to those standards daily as the leader (Kouzes & Posner, 2001, 2008). The work environment should be filled with high expectations for behavior, effort, and obtaining results. Leaders not only

model high-quality performance, but also create an environment in which coworkers can perform at a high level (Christman & McClellan, 2008).

Vision is a frequent topic in leadership, organizational development, and personal development writings. For vision to become a part of the culture of the organization, members must internalize the vision and use the vision to affect daily activities. Inspiring a shared vision is a primary focus of many leading leadership theories including transformational. Bass (1990) described business leaders with different personalities and management styles having great success due to their vision for the future and ability to encourage others to act on that vision. Hernez-Broome, Hughes, and the Center for Leadership Development summarized the potential for great leadership grounded in vision writing "transformational leaders provide compelling visions of a better future and inspire trust through seemingly unshakeable self-confidence and conviction" (2009, p. 26).

Challenging the process involves leaders taking risks to change the status quo and find innovative ways to improve the organization (Kouzes & Posner, 2001). Scribner and Donaldson described the difficulties of overcoming "institutionalized forces" relating examples of "environmental shock" necessary to lead to changes (2001). Every leader may not be called on to make societal changes, but they should work to improve the organization even when it means changing established policies, procedures, and culture.

Enabling others to act involves trust and collaboration (Kouzes & Posner, 2001; Scribner and Donaldson, 2001; Spillane, Halverson, & Diamond, 2004). Effective leadership empowers others to lead when situations allow. Leaders "strengthen others, making each person feel capable and powerful" (Kouzes & Posner, 2001, p. 66).

Distributed leadership theory furthers "enabling others" by encouraging environments in which most, if not all, decisions are made by a collective of people (Spillane, Halverson, & Diamond, 2004, Yukl, 2010).

Celebrating team accomplishments and recognizing individual contributions are categorized by Kouzes and Posner as encouraging the heart (2001). Ricketts and Rudd (2004) identified "encouragement from my teacher" (p. 247) as a major contributing factor in leadership development of students. Effective leaders provide frequent encouragement and recognition (Heller & Firestone, 1995; Maxcy & Nguyen, 2006).

In Youth Leadership van Linden and Fertman (1998) categorized traditional leadership traits as transactional leadership and the application of transactional leadership to influence others as transformational leadership. Transactional leadership concepts reflect the categories identified by Bass and Bass: (a) cognitive, (b) social competency, (c) emotional competency, (d) biophysical, (e) and character (2008). Transformational leadership concepts echo Kouzes and Posner's themes: (a) Modeling the Way, (b) Inspiring a Shared Vision, (c) Challenging the Process, (d) Enabling Others to Act, and (e) Encouraging the Heart (2001, 2008).

Businesses, researchers, and scientists have investigated leadership hoping to identify a few traits, behaviors, and attitudes that all leaders possess leading to better identification and training of new leaders. This challenge has proven to be very difficult. From a constructivist viewpoint individuals experience situations differently, thus will react to the actions of others differently. Every individual constructs meaning of events based on their personal experiences and beliefs. Each of the traits, behaviors, and attitudes are important to leadership. People have different beliefs and expectations of

leaders leading to different perceptions of what makes a good leader affecting individual's response to the requests of their leaders. In addition, developmental needs of individuals vary making leadership development an imprecise endeavor.

There may never be a short list of traits and behaviors that completely encompass what is necessary for leadership success. Traits and behaviors can be observed and improved. People can learn to successfully apply leadership in various environments and situations (Bass, 1990). This research project will observe traits and behaviors exhibited by adolescents in the hopes of learning the meaning the adolescents place on the activities as they relate to leadership development. In addition to the traits and behaviors of the youth it is important to understand the environment in which those traits and behaviors were exhibited.

Subjective and Situational Leadership

Leadership is not simply a series of traits and behaviors demonstrated by an individual. Effective leadership is as much an art as it is science. During the 1960s and 1970s authors and researchers were writing about a need for leaders and managers to better address the needs of their human followers (Bolman & Deal, 2008). Despite a movement toward a greater understanding of leadership, researchers continued to search for the traits and behaviors that would ensure successful leadership regardless of situation, gender, or ethnicity (Bolman & Deal, 2008).

In response to prominent formal (systems) management models of the 1970s and earlier, Greenfield became an outspoken critic of organizational theories which discounted the role of the individual. "It is the individual that lives and acts, not the organization. It is therefore the experience of individuals that we must seek to

understand" (Greenfield, 1984, p. 152). Individuals bring different skills, abilities, knowledge, beliefs, and perceptions to every activity they perform or observe within the organization. Each participant in the research project demonstrated different traits and behaviors in different situations. This project is not focused solely on the traits and behaviors, but on understanding the occurrence of certain traits and behaviors during specific situations in the context of the individual adolescents involved.

Greenfield's work led to additional research and the emergence of additional leadership models. Bush (2003) identified five major features of the subjective management model which is rooted in concepts espoused by Greenfield: (a) "focus on the beliefs and perceptions of individual members of organizations rather than the institutional level or interest groups" (p. 114), (b) "concern(ed) with the meanings placed on events by people within organizations" (p. 115), (c) "different meanings placed on situations by the various participants are products of their values, background, and experience" (p. 116), (d) "treat structure as a product of human interaction rather than something which is fixed or predetermined" (p. 117), (e) "emphasize the significance of individual purposes and deny the existence of organizational goals" (p. 118).

Bolman and Deal (as printed in Bush,2003) stated "the same events can have very different meanings for different people because of differences in the schema that they use to interpret their experience" (p. 115). Subjective management models believe people place individual meaning on the events within the team (Bush, 2003). People establish meaning that is "highly personal, often subtle, and subject to the values and experience of participants" (Bush, 2003, p. 117) to even minor events and that meaning will affect the individual's perceptions of future events.

Individuals place different meanings on leadership behaviors and situations as a result of their values, background, and experiences (Bush, 2003). Personal values greatly affect the meaning that a person places on an event. Events that align with their values will likely have a positive meaning. Events that differ from personal values will likely have a negative meaning. In addition, personal experience will affect the meaning assigned to an event.

Subjective leadership theory helps us understand why ambiguity exists within organizations even with leaders that seem to have positive traits, appropriate behaviors, and understanding of different situations. To fully understand leadership within the setting of this research, the situations and actions of others must be viewed from the position of each individual participant.

Leadership varies based on the specific situation (Hersey & Blanchard, 1982). Since the 1950s some attention has been placed on situational leadership. Leaders must select appropriate responses using various traits and behaviors based on the type of situation faced. “No single formula is possible for the great range of situations leaders encounter” (Bolman & Deal, 2008, p. 344). Grint (2005) proposed framing situations into three categories: tame, wicked, and critical. Effective leadership considers the possible perceptions of the other individuals experiencing the situation and will view the situation from multiple perspectives including tame, wicked, and critical (Grint, 2005; Bush, 2003; Greenfield, 1984; Spillane, Halverson, & Diamond, 2004). When viewing leadership the situation must be fully dissected taking care to understand each individuals’ view and response to the situation at hand.

Participants in this study experienced a wide variety of situations including activities they like to do and some they do not like to do as well as success and frequent failure. Yukl (2010) believes having a variety of situations is vital to an individual's development of leadership. This study looked for leadership opportunities and how each adolescent approaches the situations.

Leadership Development

Leadership development primarily focuses on learning leadership traits, behaviors, and/or various theories. Activities may include concept discussion, concept demonstration, case study discussion, coaching, mentoring, and role-playing (Gill, 2010). These activities at a minimum raise awareness and possibly skill of leadership in the participants.

One effective method of leadership development leading to practice is authentic experience (Davies & Easterby-Smith, 1984; Kelleher, Finestone, & Lowy, 1986; McCall, Lombardo, & Morrison, 1988; Mumford et al., 2000; Yukl, 2010). Providing opportunities for people to experience leadership in a real-life ongoing situation is an important learning activity of some, but not all leadership development programs. "Developmental experiences are likely to have the greatest impact when they can be linked to or embedded in a person's ongoing work and when they are an integrated set of experiences" (Hernez-Broome, Hughes, & Center for Leadership Development, 2009, p. 25).

In addition, research regarding leadership development encourages leadership trait or behavior attainment activities such as self-awareness, self-discovery, reflection, and feedback (Connaughton, Lawrence, & Ruben, 2003; Conner & Strobel, 2007;

Kouzes & Posner, 2008; Yukl, 2010). Self-awareness, self-discovery, and reflection are effective learning and important personal development activities (Avolio & Hanna 2008; Avolio & Vogelgesang, 2011; Murphy, 2011; Murphy & Reichard, 2011). Yukl (2010) proposed that the quality of leadership learning experiences is further affected by the amount of challenge, variety of tasks, and quality and acceptance of feedback.

To maximize the benefit of a leadership development experience the "situation…involves unusual problems to solve, difficult obstacles to overcome, and risky decisions to make" (Yukl, 2010, p. 467). Completing basic and repetitive tasks don't generally improve cognitive ability nor will leadership ability be developed without some challenges. Some organizations specifically assign job tasks to assist in the development of leadership (Hernez-Broome, Hughes, & Center for Leadership Development, 2009). It is not ultimately the success of the experience which determines leadership development, but the quality of the process in addressing the challenge.

Many non-leadership jobs involve specialization, but it is important to leadership development for learning to include a variety of tasks improving the likelihood of success in different situations (Yukl, 2010). Variety is important, but one must also "integrate various developmental experiences to each other as well as to both developmental and business objectives" (Hernez-Broome, Hughes, & Center for Leadership Development, 2009).

Constructive and timely feedback is an important factor in helping an individual to learn as much as possible from an experience. By reflecting on quality feedback the person can explore alternative actions and potential outcomes thus learning more from the situation (Conner & Strobel, 2007; Yukl, 2010). Karnes and Bean (1995) indicated

that adolescents viewed adult praise when accomplishing goals to be an important factor in the leadership development of the youth. Many organizations look to provide a coaching or mentoring situation in which specific individuals assist leadership development by providing regular feedback (Hernez-Broome, Hughes, & Center for Leadership Development, 2009; Rhodes & Lowe, 2008; Yukl, 2010).

Adolescent Leadership Development

Are adolescents ready for leadership development? Preschoolers, although lacking many of the traits traditionally attributable to leadership, demonstrate leadership behaviors such as relationship-building and social power (Recchia, 2011). "Small developmental experiences at an early age…can have a profound impact on future development outcomes, given the reinforcing nature of leader development" (Murphy and Johnson, 2011, p. 460). Every day, adolescents are exposed to examples of leadership and may often experience opportunities to lead. Adolescence provides a great time to begin leadership development (Kouzes & Posner, 2008; Kress, 2006; Murphy & Johnson, 2011). Adolescents identified activities such as being role models, acquiring speaking skills, and believing in the abilities of others as actions helping cultivate their personal leadership development (Karnes & Bean, 1995). The concept of developmental readiness contains four conceptual categories: self-regulatory focus, motivation to lead, learning goal orientation, and leader self-efficacy (Avolio & Hanna, 2008; Avolio & Vogelgesang, 2011; Murphy, 2011).

Fostering a promotion (positive) self-regulatory focus may develop a culture of self-improvement and advancement. Setting and working to achieve positive short-term and long-term goals helps adolescents progress obtaining valuable life skills. Individuals

experience leadership opportunities on a daily basis. Youth encouraged to make decisions and show initiative may learn new skills, grow in confidence, and develop a promotion self-regulatory focus. These positive benefits may lead to the pursuit of additional opportunities in the future. Avolio and Vogelgesang strongly believed that in order "to develop our young emerging leaders, we must instill the idea of a promotion focus – encouraging them to take on more leadership" (2011, p. 188).

Adolescents must be given the opportunity to participate in experiences that provide a challenge, a variety of tasks, and appropriate feedback (Yukl, 2010). When provided a challenge, it is important to success for the person to approach the issue from a positive and forwarding-thinking perspective as opposed to a negative perspective such as avoidance or expected failure (Avolio & Hanna, 2008; Avolio & Vogelgesang, 2011; Bass, 2008; Murphy and Johnson, 2011). Leadership development needs to be a challenge, but the youth must believe that they can be successful and with appropriate assistance and support they will be successful.

Advancing a promotion focus in people may lead to individuals being more motivated to lead. From data in the Fullerton Longitudinal Study, Gottfried and Gottfried developed a concept known as gifted motivation to describe individuals with high levels of intrinsic motivation. Further, Gottfried and Gottfried found that adolescents with gifted motivation "held significantly more leadership positions in academic as well as nonacademic extracurricular activities" (2011, p. 84-85). In addition, a need for power is often a strong motivation to lead (Bass 2008; Bolman & Deal, 2008; Gottfried & Gottfried, 2011; Kress, 2006; Lizzio, Dempster, & Neumann, 2011; Avolio & Hanna, 2008; Avolio & Vogelgesang, 2011). It is important to encourage adolescents to be

assertive in many aspects of their lives as each instance will build on one another and provide valuable experience and possibly increased ability to lead.

Avolio and Vogelgesang stressed the importance of emerging leaders being learning goal versus performance goal oriented (2011). Having goals and vision are well researched as being important for leadership (Bass & Bass, 2008; Bolman & Deal, 2008; Bush, 2003). Learning-goal-focused adolescents view each opportunity as a learning experience as opposed to simple task completion. Having a learning goal orientation may involve important leadership traits such as reflecting on events, seeking feedback, and developing self-efficacy (Avolio & Hanna, 2008; Avolio & Vogelgesang, 2011; Mitra, 2005; Yukl, 2010).

"Leadership is demonstrated every day by adolescents in their families, schools, workplaces, and communitities" (Fertman & van Linden, 1999, p. 11). Self-efficacy results from being provided opportunities and positive feedback from peers and adults (Avolio & Hanna, 2008; Avolio & Vogelgesang, 2011; Bass & Bass, 2008; Fertman & van Linden, 1999; Murphy and Johnson, 2011; Yukl, 2010). Adolescents gain confidence in their abilities as "each role they take can potentially enhance their learning ability and should allow them to approach future opportunities with more information as well as with an open mind to development" (Avolio & Vogelgesang, 2011, p. 191). People with high-levels of self-efficacy combined with a learning goal orientation may be more motivated to lead (Avolio & Vogelgesang).

Opportunities to lead. Research into servant leadership and student leadership suggest that young people can be trained to be leaders and when put into roles requiring responsibility and trust, students may develop leadership skills (Cooper, Healey, &

Simpson, 1994; Fertman & van Linden, 1999; Greenleaf, 1977; Karnes & Bean, 1995; Linden, Wayne, Zhao, & Henderson, 2008; Striffolino & Saunders, 1989). Conner and Strobel stated the "importance of continuing to give youth opportunities to stretch themselves and to grow" (2007, p.292) providing an example of a youth becoming a leader during the third year of participation in a program after receiving increased responsibilities. Murphy, a major advocate of providing leadership training to youth, writes that "research is needed to examine how existing theories of adult leadership may be transferred, and perhaps modified, to understand the processes of leadership at each developmental stage" (2010, p. 19). Many youth leadership development opportunities focus on skill and knowledge attainment, preparing youth for the future, as opposed to adult leadership development's focus on "authority (voice, influence, and decision-making power): how do, and how should, leaders apply those skills to real-life situations where significant consequences are at stake?" (MacNeil, 2006, p. 32).

Adult leadership development may be used as a guide, but Whitehead cautions that we cannot simply place adolescents into adult leadership training programs writing: "effective programs must recognize the adolescent agenda is dramatically different from the adult agenda" (2009, p. 861). Kress described a "disconnect between efforts at youth leadership education and the needs of today's youth" (2006, p. 51). Adolescent leadership development opportunities should be developed with consideration of the interests of the youth as well as their developmental stage and leadership experience (MacNeil, 2006; Murphy and Reichard, 2011).

To better meet the needs of youth, recent writings of Saunders (2005) and McNae (2010) recommend program development using a process identified as co-construction.

Involving youth and even allowing adolescents to lead the creation of leadership development programs may produce meaningful opportunities that better meet the needs of the youth. “Constructing true partnerships with students requires that youth have the space to stumble at times while being provided with enough support so that they succeed more often than fail” (Mitra, 2005, p. 547).

Successful leadership development programs provide youth “opportunities not only to develop skills and knowledge but also to apply them in meaningful and authentic ways” (MacNeil, 2006, p. 33). Adolescents must be allowed to practice leadership in an environment that allows them to experiment, succeed, and fail without undue interference from adults (Libby, Sedonaen, & Bliss, 2006; MacNeil, 2006). Karnes and Bean (1995) summarized adolescent responses to “How can parents best encourage leadership concepts and skills?” as providing “responsibility in the home, allowing decision-making on the part of students, listening to their ideas, and encouraging them to be leaders and to participate in school, community, and religious events” (p.81).

Leadership development may be enhanced when participants are presented a challenge which a person would not be able to complete by him/herself, but can solve with assistance of a team of peers (Vygotsky, 1978, Yukl, 2010). “The cultivation of effective leadership requires the ‘calculated epiphany’ that can occur through experiences that create the balance of challenge and support necessary to sustain influence” (Kress, 2006, p. 52). Mitra’s data demonstrated “the importance of group processes, including finding teachable moments that allow students to assume leadership roles and guided facilitation of meetings that allows students to see how to move forward with their goals”

(2005, p. 547). Challenging situations require participants to be social and allow for leadership development to be more authentic.

Role of the adult. Methods of implementation of adolescent leadership development are important considerations for program success. Due to the challenging nature of the Robotics Design Challenge program, some adults may attempt to take over the team preventing the adolescents from developing as much as possible. Other adults may completely ignore the youth providing very little assistance depriving them of important feedback. "True partnerships…(require) that youth have the space to stumble at times while being provided with enough support so that they succeed more often than fail" (Mitra, 2005, p. 547). At an adolescent developmental stage, youth benefit greatly from positive adult interactions.

When considering leadership development, Kress (2006) cautions, "if an adult is oriented toward serving as an expert, rather than facilitating the construction of knowledge, it does not seem likely that they will work effectively in partnership with youth" (p. 51). Deutsch and Spencer (2009) refer to this type of mentor as prescriptive - focusing on the goals the adult has for the youth. Successful mentoring must be youth-focused (Deutsch & Spencer, 2009, Mitra, 2005). Adults may assume that adolescents would adopt the goals of the program or the adults, but it is important to realize that adolescents are individuals likely with very different goals.

Adolescent leadership development and Robotics Design Challenge may work better if the adults model an authoritative parenting style providing the adolescents freedom to solve challenging problems and make decisions within a supportive

environment (Baumrind, 1991; Deutsch & Spencer, 2009; Murphy, 2011; Rhodes & Lowe, 2008). Kress (2006) summarized recommended implementation as follows:

> To be effective, youth leadership efforts must focus on creating environments in which youth matter and are part of a supportive group that knows them well enough to recognize the optimal zone where they can achieve more only with help from other people – environments where youth skill development is encouraged through hands-on participation and by recognizing that experiences are transformed by the youth who participate in them. These environments must also involve caring adults who willingly allow youth to learn from observing their actions and who engage in actions worthy of being emulated. (p. 54-55)

Adult-mentors in Robotics Design Challenge teams are not trained nor provided any substantial guidance in how to effectively assist the youth. Much of the research regarding adult to adolescent interaction focuses on mentoring in a formal program such as Big Brothers Big Sisters of America and 4-H. Rhodes & Lowe echo much of the youth leadership research statements, but cautions, "a youth-driven approach, however, needs to be balanced with structure and goals" (2008, p. 12). In addition to structure and goals, initial and ongoing training and support for the mentor and "intensity and quality of relationships" (Dubois, Holloway, Valentine, and Cooper, 2002, p. 188) are important variables to the success of a mentoring program.

Leadership is a complex concept with a wide range of traits and behaviors. Every individual appears to have some ability to lead and thus develop their leadership skills (Murphy, 2011; van Linden & Fertman, 1998). This research will consider how the Robotics Design Challenge program is implemented by the adults and seek to understand

how different experiences and implementation affect the opportunity for the youth to develop leadership skills.

Research Design and Methodology

This qualitative study investigated a problem of practice. Qualitative data analysis explored leadership development as experienced by adolescent participants and adult-mentors of the Robotics Design Challenge sponsored by the University of Missouri Engineering Department. The purpose of this phenomenological study was to explore the leadership development experiences of adolescents participating in the Robotics Design Challenge.

This study utilized qualitative research principles guided by constructivist theory allowing for emergent design. The following research questions guided the methodology and design.

Research Questions

Adolescent perspective.

1. What leadership development experiences emerge for adolescent participants in the Robotics Design Challenge?
2. How do adolescent participants describe leadership development experiences in the Robotics Design Challenge?

Adult-mentor perspective.

3. What role do adult-mentor participants play in fostering adolescent leadership development opportunities in the Robotics Design Challenge?
4. How do adult-mentor participants describe leadership development experiences in the Robotics Design Challenge?

Constructivism and Pragmatism theories influenced the research questions and design for this study. Even though the participants were involved in a semi-structured

program, the participants needed to be very flexible as each day brings new challenges. Following a constructivist perspective, each participant approached the challenges in a different manner influenced by the individual's prior-experience, knowledge, and attitude. Each participant had a slightly different perspective on his or her participation which may be different than the view the researcher has of the individual and the role the individual played in the team dynamics. The pragmatic view of this study took individual perspectives and sought to answer the research questions allowing the researcher to adjust the questions, design, and methods. The developmental-readiness level of the participants and the inquiry-style mentoring from the adults required a flexible research method allowed the researcher to "dig deeper" when appropriate.

This study investigated a problem of practice using qualitative methods approached from a phenomenological perspective. Phenomenological research emphasizes individual experiences during a shared event (Creswell, 2007; Gubrium and Holstein, 2000; Mertens, 2005). This study viewed the program participants and how they "interpret(ed) the world and life around them" (Mertens, 2005, p. 240). Each participant had a personal perspective of his or her participation in the Robotics Design Challenge. The design and methods of this study, including direct observation and focus groups, led the researcher to an understanding of what the participants experienced regarding leadership development.

Population and Sample

Robotics design challenges exist throughout the world. For the purpose of adding to existing research, providing a mid-western United States perspective, and as a matter of convenience, teams located in Missouri were considered.

Initial invitations to participate in a research study were provided to teams by employees of the University of Missouri, Appendix A. Interested teams contacted the researcher. Two schools with a total of six teams, 28 adolescents, and 5 mentors participated throughout the study.

Diversity in gender, socio-economics, and ethnicity were accounted for, but were not determining factors in team or participant selection nor resulting data, as the factors were not a focus of this research. Creswell (2007) cautions researchers regarding diversity writing, "the more diverse the characteristics of the individuals, the more difficult it will be for the researcher to find common experiences, themes, and overall essence of the experience for all participants" (p. 122). To lessen the possible impact of diversity, teams were selected based on their similarity in anticipated demographics and proximity within geographical and socioeconomic regions. Youth. Youth selected for this study were bounded by their participation in one of the six Robotics Design Challenge teams selected. Both schools hosted after-school robotics programs with the University of Missouri Design Challenge as the driving force for the program. Youth participation in each school was voluntary. Each school had a limited number of participants. Fourth and fifth graders received priority and took up every available spot. One site selected youth based on timing more than any other factor (first-come first-served) and the other site randomly drew names of the qualified applicants.

Participants and parents received and returned signed letters of informed consent, Appendices B and C. All youth participants in a team were expected to participate in the research. If a youth did not wish to participate in the research then the team was not used and an alternative team was sought.

In addition, the researcher understood that due to illness or conflicting schedules there may be instances in which an observation was scheduled, but one or more youth were not able to be present for that particular meeting. Given the qualitative state of the research, it was determined throughout the process if additional observations were necessary. Consideration was given to the idea that the absence of individual team members introduced a dynamic into the team in which leadership from other youth may be necessary, bringing about an excellent observation opportunity. After one rescheduled observation, each team was observed prior to the challenge three times. There were two youth not present for the individual focus groups. Due to the nature of the focus groups, no rescheduling was sought.

Adult Mentors. Adults selected for this study participated and actively mentored one or more of the six Robotics Design Challenge teams selected. All adult mentors received and returned signed letters of informed consent, Appendix D. Not all guardians or parents were considered adult-mentor participants. Only adults considered active by the adult team leaders were considered an adult mentor participant thus included in the final focus group. All adult mentors were expected to participate in the research including the focus group. If an adult mentor did not wish to participate in the research then the team was not used and an alternative team was sought. One adult-mentor was not able to continue participating in the after-school club halfway through. It was determined that since the two teams involved still had two quality mentors, similar to the other teams, the study would not be adversely affected.

The adult mentors were very important to the success of this research. Individual characteristics of the adults possibly affected the activities of the youth. The researcher

had no voice in what the adult mentors did during observations or at the unobserved meetings. Although there are no explicit guidelines from Robotics Design Challenge, it appears they prefer adult mentors to exhibit behaviors similar to authoritative parenting versus authoritarian, permissive, or uninvolved. Parenting (adult mentoring) styles was not a focus of this research, but the researcher was prepared to account for the actions and behaviors of the adult mentors if necessary. Table 1 below provides basic descriptive information of the adult mentors.

Table 1

Adult Mentor Description

Site	Identification	Age Level	Occupation	LEGO Robot Experience?
Rural	Adult1	46 – 55	Teacher Non-core	No
Rural	Adult2	56 – 65	Science and Math Field Retired	No
Urban	Adult3	46 – 55	Teacher Core	Yes
Urban	Adult4	46 – 55	Teacher Non-core	Yes
Urban	Adult5	16 – 25	Student	Yes

Population Demographics

Demographics did not factor into the selection of teams or individual participants. Demographic identification data collected included participant name, birth date, gender, race, grade level, and years participating in robotics' programs. The researcher analyzed demographic subgroup data to determine if demographics played a role in the data. Chapter 4 of this report includes specific examples of instances in which demographics possibly played a role in the data. Adult mentor data included the relationship to specific youth participants: teacher or community volunteer, as that relationship may have

affected the youth's behavior or statements. Table 2 below provides basic demographic information of the schools (Guided Inquiry, 2015).

Table 2

School Demographics

Site	School Percent White	Participant Percent White	School Free/ Reduced Lunch
Rural	95.0	100.0	22.2
Urban	37.7	81.8	76.2

Data Collection Procedures

To ensure reliability, qualitative data collection included (a) team meeting observations, (b) a youth focus group, (c) an adult-mentor focus group, and (d) team after-event debriefing. The research questions focused the data collection on leadership and leadership development experiences of the youth. The qualitative research concept allowed the researcher to investigate related concepts in more detail if the situation warranted.

Team meeting observations. Observations of team meetings occurred from January 2015 through April 2015. The researcher observed each team three times for sixty to one-hundred and twenty minutes each at the team's normal meeting location. The observations were spaced apart roughly occurring early, middle, and late in the 3-month program. The observation protocol used during team meetings can be found in this report as Appendix F. In addition to the observation protocol, informal jottings were taken and subsequently analyzed. The observed meetings were passively videotaped then transcribed and analyzed.

Youth focus group. One youth focus group occurred for each team in April 2015 after their local competition. Youth team members participated in one focus group lasting from 45 to 60 minutes. To encourage quality reflection and responses from everyone, the youth were given each question (Appendix G) followed by time for reflection and time to record a draft response. Participants shared their individual thoughts after which discussion amongst the group was encouraged. Expecting each participant to respond aligns with the conceptual framework of this research and the importance of the individual. Providing time for the participants to add to the responses in a discussion format further enhanced the responses providing a deeper and richer view of leadership development.

Adult-mentor focus group. Adult-mentor focus groups occurred for each team in April 2015 two and three days after the Robotics Design Challenge event. Each participant shared individual thoughts then freely discussed the prompts as a group.

After-event team debriefing. As a part of the MU Robotics Design Challenge, teams participate in a debriefing immediately following their 7 minutes running the challenge course. During this short debriefing, the teams are asked about challenges, decision-making, and overall reflection on how the team performed. The structure and atmosphere of the debriefings was casual, but it provided this study an additional opportunity to view behaviors and potential leadership opportunities.

Human Subjects Protection and Other Ethical Considerations

The study complied with the Campus IRB review process of the University of Missouri under the guidelines of the federal Office of Human Subject Research Protection. Everyone participating in an observation or a focus group completed an

informed consent (Appendices B, C, D, and E). The informed consent form included study description, purpose, timeline, participation expectation, potential benefits, potential risks, and confidentiality.

The study involved youth aged nine through eleven and observations of their growth, or lack thereof, of leadership traits and behaviors and the interactions the youth have with their adult mentors. Observations tracked both positive and negative traits and behaviors and the interplay of the individuals. Focus group questions focused on positive traits and behaviors with no inherently negative items. The informed consent forms (Appendices B, C, D, and E) signed by youth and their parent/guardian included information regarding data collection including the focus group and encouraged participants to view the process as a growth opportunity and not a disapproval of current leadership abilities.

All data was and continues to be held by the researcher as strictly confidential. An alias naming system was developed prior to each data collection instance and changed throughout the data collection stage. The aliases used for this dissertation are different from the data collection stage.

Permission was sought and received in September, 2014 from Dr. Satish Nair, Professor of Electrical and Computer Engineering and Professor of Biological Engineering. Special care was taken to remind the organizations that this is not a program evaluation and the results do not reflect positively or negatively on the Robotics Design Challenge, the schools, the organizations, nor the individual participants.

Role of the Researcher

The researcher was the sole contact person for the Robotics Design Challenge teams involved. The researcher communicated with the adult lead, observed at least three team meetings, the after-event team debriefings, and facilitated the focus groups. Throughout the study, the researcher bracketed his own beliefs about leadership and leadership development. Doing so, the researcher took a fresh look at leadership within the Robotics Design Challenge context and focused on the data as it developed. During the data collection and analysis time periods, the researcher discussed the data and emerging themes with his dissertation chairperson. Issues were immediately addressed and if necessary the data was reanalyzed.

Due to the nature of qualitative research, brief conversations with participating youth and adults happened. The researcher attempted to stay away from topics related to the competition, leadership, or leadership development. Upon completion of each conversation the researcher reviewed the content and determined if information should be shared with the other teams in the study or the dissertation chairperson. Observing the brief interactions in the videos, the researcher is confident that none of the interactions affected the behaviors of the individuals, the performance of the teams, the integrity of the competition, or the outcomes of this research.

Data Analysis

This phenomenological study utilized qualitative research principles guided by constructivist theory to explore the leadership development experiences of adolescents from the perspective of the adolescent, the adult mentors, and the researcher. Following principles of subjective and situational leadership, the experience of individuals and the

situation were important to understanding the possible presence of leadership development (Bass, 2003; Greenfield, 1984). Leadership development principles such as traits and behaviors along with other models served as a lens to understand how the behaviors and statements of the adolescents may indicate leadership (Connaughton, Lawrence, & Ruben, 2003; Conner & Strobel, 2007; Gill, 2010; Kouzes & Posner, 2008; Yukl, 2010).

Using a phenomenological perspective special emphasis was placed on individual's significant statements, and "quotes that provide an understanding of how the participants experienced the phenomenon" (Creswell, 2007, p. 61). In addition to themes that developed, individual experiences continued to be important as the researcher attempted to understand the meaning of the leadership development experience for each participant in line with subjective leadership theory (Bush, 2003; Creswell, 2007). Video recordings were watched and the transcripts read numerous times while performing precoding and jottings. Following suggestions of Johnny Saldaña (2013), important instances were highlighted and researcher jottings included first impressions of the events and possible connections to previous or future occurrences. Using multiple coding methods, initial, descriptive, in vivo, emotion, verbal exchange, pattern, and focused captured the individual's experiences.

Focus Group transcripts were analyzed following the guidelines of Tesch: (a) read all transcriptions, (b) reread a few documents and write down topics found in each, (c) cluster the topics found, (d) use the topics to identify parts of additional writings adding topics as necessary, (e) revisit topics including the new ones and re-categorize creating a concept map to show the relationship of the topics, (f) finalize the names of categories,

(g) organize data by category, (h) revisit all data labeling properly (as cited in Creswell 2009). Meeting observation data was (a) reviewed, (b) categorized by individual, (c) labeled in a manner similar to Tesch's guidelines above, (d) reread, re-categorized, and relabeled after each subsequent observation, (e) labeled by topic, (f) and categorized. After coding, categorizing, and labeling the data from the four primary sources – meeting observations, after-event team debriefing, youth focus group, and adult mentor focus group – the researcher compared and contrasted the findings in order to "triangulate" the data. Recurring themes in addition to individual statements provided the basis for the findings. The researcher compared the categories and developing themes with prior research and theories.

Summary

Using qualitative methods, this research project explored adolescent leadership development within the context of Robotics Design Challenge teams from January 2015 to April 2015. Observations from team meetings, youth focus groups, adult-mentor focus groups, and documentation provided rich data that was analyzed from a phenomenological perspective. Approaching this study from an emergent design lens, the researcher thoroughly investigated the events as they occurred including identifying additional published research. The research questions provided focus, but when appropriate other factors were considered, such as gender, to fully evaluate the meaning of the events from the perspective of the individual adolescents, the adult mentors, and the researcher. Extensive data analysis combined with existing research results led to the emergence of the findings outlined in this dissertation adding to existing literature in the

field of adolescent leadership development and potentially the construction of adolescent leadership development theory.

Results

This phenomenological study utilized qualitative research exploring the adolescent leadership development of youth participating in the Robotics Design Challenge. Constructivist theory led the researcher to pay close attention to individual experiences from the perspective of the adolescent and the adult mentors (Starrat, 2001). Subjective and situational leadership principles were important to understanding the possible presence of leadership development within each situation (Bass, 2003; Greenfield, 1984). Leadership development principles guided coding and analyzing to give meaning to the traits and behaviors observed by the researcher (Connaughton, Lawrence, & Ruben, 2003; Kouzes & Posner, 2008; Yukl, 2010).

The following results attempted to answer questions regarding the experiences of the adolescents and the adult mentors within the robotics challenge environment. Within the challenge activities, would there be opportunities for leadership since the youth may experience an environment identified as important for leadership development (Yukl, 2010). How did adolescents experience the leadership development opportunities, since they were not purposely participating in leadership development? What role did the adults play and how did their actions affect the potential for leadership development? The final research question asked the adults to reflect on their perspective of the adolescents leadership development.

As delineated in Table 3 below, one site had two adult mentors, who guided four teams: Alpha, Delta, Beta, and Gamma. The adolescents in the study were ages 10 through 12. Team Alpha consisted of four boys. Team Delta comprised of two boys and two girls. Team Beta consisted of three boys and two girls. Team Gamma comprised of

two boys and two girls. A second site had three adult mentors, who guided two teams: Epsilon and Zeta. Team Epsilon consisted of three boys and three girls. Team Zeta comprised of four boys and one girl.

Table 3

Robotics Challenge Teams and Team Membership by Gender

Adult Mentor Gender		Robotics Team	Adolescent Team Member (Gender)	
Male	Female		Male	Female
Adult2	Adult1	Alpha	A1 A2 A3 A4	
		Delta	D5 D6	D7 D8
		Beta	B9 B10 B11	B12 B13
		Gamma	G14 G17	G15 G16
	Adult3	Epsilon	E19 E20 E21	E18 E26 E28
	Adult4 Adult5	Zeta	Z22 Z24 Z25 Z27	Z23

Over three months, the participants participated in team meetings, a challenge event, a team debriefing, and focus groups. Individual statements and actions created a rich pool of data. Analyzing and coding the data led to the themes identified below regarding leadership development and the experiences of the adolescents and adult mentors in the robotics design challenge.

Emerging Leadership Development

Participation in the Robotics Challenge provides insights into the emergence of leadership skills and development among adolescents. Every day, in which the youth participated in preparation for the Robotics Design Challenge, they experienced an environment rich with leadership opportunities. Redmond and Dolan (2016) proposed an environment of adolescent leadership development consisting of authentic opportunity and mentor access. Yukl (2010) proposed that the amount of challenge, variety of tasks,

and quality and acceptance of feedback affect leadership-learning experiences. To answer the question, what leadership development experiences emerge for adolescent participants in the Robotics Design Challenge, this research project described examples of experiences in the categories: authentic opportunity, mentor access, amount of challenge, variety of tasks, and quality and acceptance of feedback.

Authentic opportunity. "For young people to take on the responsibility of leadership, they need to be given genuine opportunities where they get to practise real leadership and learn from doing so" (Redmond & Dolan, 2016). Both research-site locations provided youth participating in the Robotics Design Challenge the opportunity to attend weekly meetings for three months and a one day challenge event hosted by a local university. During the meetings, the youth worked in small groups to learn and apply robotics design and robotics programming attempting to accomplish daily challenges as identified by the adult mentors.

The opportunities for leadership in this program may be more authentic than programs intending to develop leadership. Since leadership was not the focus, nor even mentioned to the youth, the individual's instincts, traits, and behaviors surfaced in line with situational leadership and subjective leadership theories (Greenfield, 1984; Hersey & Blanchard, 1982; Spillane, Halverson, & Diamond, 2004). Each day the groups of youth experienced situations that naturally generated opportunities for leadership practice. Each step of the process, youth needed to verbalize an idea, work collaboratively, physically manipulate the hardware, edit the computer program, analyze the situation, and solve a problem. Upon overcoming a challenge, the youth moved onto the next step, which offered more opportunities for leadership. For example, during one

of the site team meeting observations, the youth worked in small groups to review the operations of the light sensor, program the robots to find a line using the light sensor, then follow a line, then turn while following a line, then create their own lines for the robot to follow.

Mentor access. Mentors provided support and help as the adolescents worked through the challenges of the program (Redmond & Dolan, 2016). The adult mentors were very active providing guidance throughout the process. The ratio of adults to youth and adults to groups/teams fluctuated. One site had seventeen youth throughout the researcher's observations mentored by two adults, in their first year of the robotics challenge, for a maximum ratio of one adult for every nine youth. The other site had three adult mentors, all with some previous robotics challenge experience, with two being present at any given moment. With eleven youth, the maximum ratio was one adult to six youth. Both sites had youth working in small groups allowing the adults to mentor anywhere from one to five youth at one time. Constant mentoring by the adults greatly enhanced the daily and long-term success of the groups even though the activities led the youth to be active participants. The adults verbalized the group goals, provided technical instruction, created a structure for success, used inquiry-learning techniques, answered questions, and motivated with general and specific feedback.

Two frequent tasks of the adult mentors were to provide structure and to identify roles. Structure was important, and this paper includes additional examples later in this chapter. Especially due to the age and maturity of the youth, occasionally it was necessary to set rules such as when A1 found youth standing in the middle of the track and said, "Boys, get out of the maze. You do not need to climb in it. Thank you!" The

second frequent task of the mentor was to infuse structure into identifying roles, ensuring that all of the team members had an opportunity to do various tasks (Rhodes & Law, 2008). In the following example, team Epsilon approached the test track:

> Adult3: "Okay. Let's make a team decision on who claps. There's three people on the team."
>
> E18: shakes head, lifts arms, and says, "no!"
>
> E19: "Okay so I'll be the starter."
>
> E19: "You guys ready?" E21 moves in position to be the clapper and the robot is then tested.

Having access to adult mentors allowed the youth to learn and practice in a positive and structured environment. In the discussion above, Adult3 does not assign the tasks, but defers the decision to the team members. E18 declines the role of clapper, while E19 accepts the role of starter. E21 quietly steps up to accept the role of clapper as E19 starts the test. Adult3 provides structure and guidance creating an environment safe for E19 and E21 to accept the current responsibilities within team Epsilon. As a mentor, Adult3 recognizes her role as a guide providing the adolescent team members the structure and opportunity to develop leadership (Mitra, 2005; Redmond & Dolan, 2016; Rhodes & Lowe, 2008).

Amount of challenge. The technical challenge included the youth learning a new skill, analyzing success or failure of frequent robot tests, creating solutions to address the Robotics Design Challenge, and dealing with adolescent-team dynamics. To develop leadership skills and behaviors, the adolescents must face challenges difficult enough to benefit from the support of the adult mentors (Deutsch & Spencer, 2009; Yukl, 2010).

Three program participants had previous experience with the concepts of programming and the skills used for this challenge. Based on the observations of the researcher, the three with experience could be considered beginners. Both sites provided traditional lecture-type distribution of technical knowledge. Following is the text of one such example to illustrate the magnitude of challenge:

> Adult5: "When we program [the robot], who remembers what our move block is called?"
>
> None of the youth quickly raises a hand. E19, usually one of the first to raise a hand, slowly raises his hand.
>
> Adult5: "go for it, try."
>
> E19 incorrectly says, "Uh…the move block…"
>
> Adult5: "Do we say..."
>
> E19: "Hold on, hold on, I think I got it."
>
> E20: raises his hand.
>
> Adult5: "Can E20 help you?"
>
> E19: "Ah…"
>
> Adult5: "Why don't you go for it E20?"
>
> E20: "I don't, what was the question?" The mentor provides additional guidance in the form of additional inquiry with context clues.
>
> Adult5: "For the move block, do we use rotations or seconds, or what do we call it, what we use?"
>
> E20: "Oh." E20 started to say more but others were raising hands and Adult5 motioned to

E21: "Unlimited."

Adult5: "Unlimited perfect."

E19: "Yes, I was going to say that. I thought it was something like unlimited."

E19 and E20 were initially confident that they knew the answer, but they were incorrect. Similar interactions took place at both research sites as learning and implementing the robot programming skills challenged the youth. One factor identified by Yukl for leadership development was the level of challenge (2010). The robotics challenge concepts and skills were new and difficult to most of the participants. To develop leadership E19 and E20 would need to overcome initial adversity and persevere to overcome the challenge (Bass & Bass, 2008; Redmond & Dolan, 2016; Yukl, 2010). To solve challenging problems and possibly develop leadership, people need to communicate and work with others to overcome adversity (Redmond & Dolan, 2014; Yukl, 2010).

The following team experiences several challenges and problems that needed to be solved. The conversation took place over the span of about 10 minutes in which E19 and Z27 experienced frustration and confusion while facing various programming challenges. Eventually their persistence pays off as the robot successfully accomplished the goal:

Adult5: "It's going backwards because this is backwards."

Z27: "Oh yeah, we put frontwards first."

E19: "Yeah and it's not working."

Adult5: "Well why don't you put forwards and we'll look at that."

Z27: "It went backwards whenever we put forward, it went forward and it went backwards when we did backwards."

Adult5: "Well we have to keep trying it. Did you download it?"

Z27: "Yeah. Wait, no."

Adult5: "Okay. Yeah, that might be the problem. Well let's download it and let me see what happens."

Z27: "This has it going forward."

E19: "Let's test it on the floor."

Z27: "Look, it's going to go backwards."

Robot was tested.

Z27: "It went backwards."

Both E19 and Z27 were new to programming robots. At this time, the amount of challenge is substantial, as they cannot figure out why the changes they make in the software are not changing the results on the track. Even with the frustration, E19 and Z27 continue to communicate and work together to find a solution.

Adult5: "Put it backwards and download it and then we'll see what happens."

E19: says something to Adult5 that was not heard.

Adult5: "Z27 said you didn't download it so let's"

Z27: "I didn't say that. I never said that."

Adult5: "I asked you."

E19: "I'll try downloading another one."

Time passed as E19 and Z27 worked together changing the settings in the software.

E19: "I think we have it."

Robot was tested.

E19: "Oh. I don't know why it's not working. Let's try this. Should we try the…Oh dang it, Z27, I have a problem. This fell off. We kind of have a problem here."

Parts fell off of the robot creating more frustration. Z27 for the next few minutes watches the other activity in the room. Adult5 walked by and offered assistance. E19 is discouraged, but remains active, helping Adult5 work on the robot.

Adult5: "Okay, let's see. Let me see that. Think that goes right here."

Adult5 helped reassemble bot with a new sensor.

Adult5: "Okay, here you go."

E19: "Let's try the new sensor. Looks like brand new." E19 continues to make some physical/building changes to the robot.

E19: "Hold on, let's set it to forward."

E19 made changes to the program and downloaded the program to the robot.

Robot was tested.

Z27: "Let's do the back." More changes were made to the program.

Z27: "Okay, now let's try it.

E19: "Maybe it doesn't, maybe there's something wrong."

E19 tested the robot on a table while Z27 went to watch other groups on the track. Z27 was helpful, but when he could not figure out a solution, other things happening in the room easily distracted him and he allowed E19 to take over. E19 went to get Adult5 to come help.

E19: "We deleted the wait and it did nothing."

Adult5: "Okay, what does that say?"

E19: "Shredder, that's ours."

Adult5: "What does this say?"

E19: "Title One"

Adult5: "Yeah you're using the wrong program. You got to make sure that what it says on here is what it says up here because you've been running..."

Z27 returned to the group's workstation.

Adult5: "Do you know what I'm talking about? You have to look and see what the screen says and what this says because you guys are running the wrong program which is why you're going backwards."

Z27: "Oh."

Adult5: "Yeah, so just make sure that everything matches up."

Robot was tested on a table.

E19: "Yes! It works."

Adult5: "Yay, okay, so why don't you try it with the maze with the right program right?"

Adult4: "You guys ready?"

Robot was tested.

Adult4: "There you go, there you go."

E19: "Oh dang."

Adult4: "Do that again. That was good E19. Nice Z27."

The amount of challenge experienced by E19 and Z27 caused frustration. In the beginning, the adolescents continued to work together to find a solution. Eventually E19 stepped up continuing to troubleshoot while Z27 was distracted by his surroundings. Yukl explained that "learning from experience involves failure as well as success" and "experiencing success in handling difficult challenges is essential for leadership development" (2010, p. 467). During this challenging time E19 demonstrated leadership concepts of social skills, problem solving, focus, persistance, and goal orientation.

Robot and programming issues were not the only challenges. In the end, six teams participated in the challenge. Some of the teams had excellent teamwork highlighted later in this research, but other teams faced conflicts. The team in the following situation had teamwork issues throughout the challenge. The adult mentors knew and addressed several instances in which the team members conflicted. Two of these youth did not get along. Adult1 explained how each team would have four youth, but for that day two youth will work with one robot to program for half of the track and the other two youth will have a second computer to work on the other half of the track. D6 and D5 were assigned to work together even though they do not get along. Moments before the following dialogue, D6 switched the groupings and was caught by the adult mentor and told that everyone in the team must agree to the changes. D6 for the second time changed today's groupings by moving around the 'role' stickers.

> D8: "I don't want to trade." After a short pause continues, "I'm not fine with that, you can't trade. I'm not fine with that."
>
> D5: "Dude, I'm not gonna be bad, so good luck." D5 to the video camera so the others do not hear says, "I hate him [D6]."

D6: "You said you wanted to."

D5: "I never said I wanted to be bad."

D6 was assertive in rearranging the partner assignments, but his motivation appeared to be selfish. D8 'hated' D6, but showed flexibility and discipline in choosing to work with him over getting in trouble. The Delta team continued to have opportunities for leadership development

The adolescents were challenged to learn a new skill, analyze success or failure of frequent robot tests, create solutions to address the Robotics Design Challenge, and deal with adolescent-team dynamics. These activities forced some youth to step up whenever possible. The individual experiences were different, but the challenge created an environment that provided an opportunity for individual leadership development.

Variety of tasks. To develop as a leader, individuals must resist specialization and embrace a variety of tasks in different situations (Yukl, 2010). Tasks in the Robotics Design Challenge included building, programming, data entry, testing, analyzing, problem solving, communicating, collaborating, starting, clapping, transporting, recording, and more. Relatively late in the program, team Zeta needed to build a second robot. Following is a quick discussion demonstrating several key tasks:

Z25: "Let's just build our stuff which we have no idea how to do."

Z24: "I do. I have the instruction book, and I know how to do it." There is indistinguishable chatter as all four team members start to build and talk about how to do the build.

Z24: "How about we take turns building."

Adult3: "How about if two people build it and two people continue to program."

Z25: "Me and Z23 build."

Z24: "Me and Z22 run the program."

Z25 speaking to Z23 says, "How about me and you just program."

Z23: "Yeah, no, no." She hesitates as she enjoys being the builder.

Z22: "You guys build. We program."

Z25: "We are building. Let's rock!"

Throughout the challenge experience, the youth performed a variety of tasks, such as building, planning, programming, and testing. Yukl (2010) identified variety of tasks as important to leadership development as people learn about the day-to-day operations of the organization especially the people being led. When Team Zeta needed a second robot, Z25 quickly expressed the team's goal, but expressed personal doubt about knowing what to do. He demonstrated leadership by organizing the upcoming roles, but also demonstrated the need for variety of tasks within leadership development. Z25 hesitated and allowed Z24 to step up and lead when he realized he did not know enough to build the robot. When Z23 expressed a desire to build, Z25 built on that confidence with an emphatic, "We are building. Let's rock!" Identifying and rotating roles and tasks was important for team dynamics as well as the individual's abilities and confidence in performing those roles. In contrast, within the adult-mentor portion of this research paper, the adults will reflect on variety of tasks and how more specialization may have created youth with greater knowledge and more confidence to take more of a leadership role.

Quality and acceptance of feedback. Adult mentors provided frequent and quick feedback primarily to celebrate success, such as "so close" or "great job." Adolescents view adult praise when accomplishing goals to be an important factor in the leadership

development (Karnes & Bean, 1995). Although not as frequent, occasionally youth provided feedback to other youth such as when D6 said "nice job!" to G15 and G16 after they tested their robot and B10 said "guys doing good" to A1.

The following conversation is a good example of the back-and-forth communication between youth and adults to encourage and teach:

> E20 and E28 tested their robot. The robot is supposed to cross over a line on the floor then turn when the ultrasonic sensor is activated by an object being nearby. During this test the robot did not turn when expected. E21 and Z22 offered advice.
>
> Z22 attempted to explain that the sensor works best when a hand comes from the side and not the top, "Got to go on the side."
>
> E21: "Got to go from the side and check the back wheel."
>
> Z22: "Check the back wheel. They mess up easily."
>
> Robot was tested.
>
> E21: "It saw your hand."
>
> Adult5: "Yeah, what distance do you have?"
>
> Adult4: "His did just work. His turn came here." Several minutes earlier, this group's robot turned at the correct time.
>
> E21: "Yeah, you just need to come from the side."
>
> Adult4: "Here, let E21 help you. E21, help." E21 moves down closer to the bot and demonstrates how to place his hand so that the sensor works.
>
> Adult4: "E20 did you see how his hand. Let E20 do it, you do it. Get your hand way down low below his eyes."

Robot was tested.

Adult4: "There you go. Good E20 good. Little bit more turn." The group of E21, Z22, and Z24 then tested their robot.

Z24: "Come on E21"

Z22: "Okay, we can do this."

Without prompting from adults, E21 and Z22 provided feedback and technical assistance to members of another team. The adults encouraged E21 and Z22 to continue helping. The adult mentors frequently acted like coaches providing positive praise, such as "great job" or "you can do this" (Rhodes & Lowe, 2008; Yukl, 2010). Praise helped build confidence and encouraged focus on accomplishing the short-term goals. Positive and constructive feedback from the adults created an environment in which the adolescents could learn, succeed, and develop as leaders (Karnes & Bean, 1995).

Leadership development experiences emerged due to the nature of the Robotics Design Challenge: authentic opportunity, mentor access, amount of challenge, variety of tasks, and quality and acceptance of feedback. The design challenge and the adult mentors created an environment in which each adolescent had the opportunity to show initiative and demonstrate leadership traits and behaviors in a variety of situations. With the potential for leadership development, how would the adolescents experience leadership?

Leadership Development Among Adolescents

For approximately three months, the youth experienced adult-mentor guidance within an environment in which the adolescents could explore and develop their leadership skills. Since the focus of the challenge was not leadership, the youth did not

think about leadership as the opportunities arose. Brungardt (1997) wrote "almost every activity of experience could be credited to having some role to play in the development of our personal leadership behavior and style" (p. 84). Research question two explored how adolescent participants experienced leadership development in the Robotics Design Challenge.

The data coding process of this research identified examples of about 40 traits, behaviors, concepts, and theories demonstrated in the team meeting observations, after-event team debriefings, youth focus groups, and adult mentor focus groups. Additional coding passes, data analysis, categorizing, and labeling led to four frequently recurring themes from the adolescent perspective: confidence, knowledge, teamwork, and problem solving.

Leadership Development Through Confidence. Adolescents gain confidence in their abilities through learning and practice (Avolio & Vogelgesang, 2011; Bass & Bass, 2008; Redmond & Dolan, 2016). The Robotics Design Challenge tested the youth and required them to learn and demonstrate that they have a certain level of knowledge. The first and most prominent trait visible in the researcher's observations was confidence and lack of confidence.

A common observation of confidence is when an adult asks a question, a youth will raise a hand or begin to speak. A person's confidence in a situation leads to greater efficacy which is "critical to leader development" (Avolio & Hannah, 2008, p. 337). Several times an adult asked a question, youth raised their hands, and the person volunteering to answer the question did not know the answer. The youth demonstrated

unwarranted confidence in the situation. In the following example the first two students volunteering a response do not know the answer:

> Adult1: "What is the symbol for the light. . . the light sensor? You've had some experience with the programming, what do you think? What's that little icon going to look like?
>
> B10, B13, A3, D8 raised their hands. Adult1 called on D8 to answer.
>
> D8: "Umm"
>
> Adult1: "Just what's that little icon look like. And maybe you haven't seen it before. Don't feel badly if you haven't." Adult1 was careful to keep the environment positive and keep the youth from losing their confidence. Adult1 spoke directly to D8, "Do you know what it looks like?" D8 was silent. B10 raised his hand again.
>
> Adult1: "No. Okay, B10, what's it look like?"
>
> B10: "I'm pretty sure it's flashlight?"
>
> Adult1: "It kind of looks like a flashlight? I'm not sure of that." Adult1 motioned to B13.
>
> B13: "Like a circle and a checkered black pattern and it's either dark or light." D8 quickly raised her hand even though she did not know the answer. B10 raised his hand twice and provided an incorrect answer. D8 and B10 were confident that they would be able to supply the answer, but were not correct. Confidence is a trait of leaders and those that raise their hands demonstrate confidence (Redmond & Dolan, 2016).

At the other research site, a few youth were also quick to raise their hands when asked a question, for example:

Adult5: "I know we've gone through all the different sensors. Can somebody tell me what one of the sensors is? Z25"

Z25: "Light sensor."

Adult5: "Light sensor. Okay. E19?"

E19: "Ultrasonic sensor."

Adult5: "Ultrasonic."

Z24: "Touch sensor."

Adult5: "Touch sensor. Okay. Who knows the last one? Yeah."

Z22: "Ultra…no, no, no, wait."

Adult5: "We got light, ultrasonic, touch. What's the last? Can E21 help you out? E21 you want to say it?"

E21: "The sound sensor."

Adult5: "Yeah, the sound sensor."

Six of the eight youth present for this question raised their hand in hopes of providing a response. The students were motivated to do well and confident that they could recall what they had previously learned. This confidence in their learning demonstrates an openness to further development (Avolio & Vogelgesang, 2011; Murphy, 2011).

During the researcher's second observation, one site turned their focus on the specifics of the challenge event. The youth were doing additional brainstorming and planning when Adult5 approached a team to check on their progress. The team worked on creating a drawing/map of the track and deciding which sensors to use at certain locations. Z25 immediately spoke up saying, "My ideas are not on the map but on the sensors, like what we could really use."

Adult5: "Do you want to write up the steps? You could write up step 1. What you guys want to do that you talked about. You talk about what to do and you can write up your steps. Is that a good idea?"

Z25: "Nah, we already have that on there."

Adult5: "That's what you have here."

Z25: We got the map, what we're going to do, and the steps."

Adult5: "Okay, perfect."

Z25 was very brave to speak up in the first place, but being very confident in the work of the group by responding to the adult by saying, "Nah, we already have that."

Approximately fifteen minutes later within a different situation, the following conversation took place:

Adult5: "How is it going?"

Z25: "We're now on the computer, but its taking forever!"

A few seconds passed by then Adult5 says, "Z25, you got to help"

Z25: "I don't know how to help."

Adult5: "You don't know how to help?"

Z25: "We already got the planning done. I just don't want to work on the computer."

Z25 frequently spoke first showing confidence and motivation to lead, but here he expressed less confidence with the task of programming. This situation permitted other members of the group to step up as Z25 willingly assumed a secondary role (Hersey & Blanchard, 1982; Yukl, 2010).

In the following short dialogue, three team members demonstrated confidence in three different ways after a close but unsuccessful robot test:

> E19 had an idea and wanted E21, the perceived leader of the group, to listen, "Can I just show you something?"
>
> E21: "Won't work we already tried that."
>
> Adult3 spoke to the group questioning the angle at which they had the robot traverse. Adult3 motioned a different path the robot could take and said, "it would be tricky, but you got to get to here."
>
> E18 confident in the past group decisions, motioned a path while saying, "We were trying to get to this spot and going over." (mostly motioning)
>
> Adult3: "Okay, alright, I see what you are saying. You have a good point. I changed my mind."
>
> E21 then allowed E19 to make changes to the program on the computer.

In this interaction, E19, confident that his idea might work, asked the perceived leader of the group if he could make a change to the program. E21 having gained confidence in his knowledge of the programming immediately said that E19's idea would not work. Adult3 offered a suggestion, and E18 was confident enough to speak up and explain what the group's thinking was in solving the challenge.

During the researcher's first observation, E21 did very little to garner any attention. E21 was quiet and shy, only raised his hand a few times, and appeared to be content with following others. By the second team-meeting observation, E21 was very patient and allowed others to participate in the team, but the others clearly looked to him to lead with his knowledge of the robot, programming, and problem solving. Although

research tells us that intelligence does not correlate with ability to lead, within the robotics design challenge, the adolescents with greater knowledge frequently were expected to lead by the other youth (Bass & Bass, 2008; Murphy, 2011). The following conversation was the researcher's first observation of E21 being verbal. Even though the confusion ended up to be his misunderstanding, he was very assertive even saying, "No" to the adult several times. In the end, he continued to be polite, was not upset, and was engaged in the process.

E18: "Something's wrong."

Adult5: "What went wrong?"

E19: "Oh, we didn't check the wheel."

E21: "No, I did E19."

Adult5: "Why don't you start it again?" A few moments passed.

E21 was confident that the robot was going to work. He confidently rebuked E19's suggestion. He immediately wanted to fix the program so he left the group and went towards the computer.

Adult5: "Hey E21. E21?"

E21: "Yeah?"

Adult5: "I don't want you to change anything without talking to your team. Why don't you guys talk about what went wrong or maybe try it again."

E21 returned to the testing area.

Adult5: "E18, why don't you try it again?"

E21 speaking to E19 said, "You said you did try and added a zero, right?"

E19 shook his head yes. E21 returned to the computer.

Adult5: "Okay. E21 come over here so you can see what happens."

E21: "No. I know what happens."

E21 assertively said "no" to the adult mentor showing confidence. He was confident that there was an issue with the program even though he thought they were putting in the correct values.

Adult5: "Okay. You know what's happening? It's trying to run over that wire."

E21: "No that's not what's happening."

Adult5: "Okay so why don't you move that wire. Do you see it?"

E21 walked closer to Adult5 and explained to Adult5 "whenever we programmed, it was a zero in the decimal. It won't put zero in. We tried it twice now."

Adult5: "Are you talking about when it stops?"

E21: "Yes."

Adult5: "That's not until much later, so something is happening to your program at the beginning, right?"

E21: "No. It's exactly what's happening. It was supposed to go point ten (.10) rotations but it's only going point one (.1) rotation. When we programmed, it didn't use the zero."

Adult5: "Let's try it one more time. E19 get ready to..."

Z24, a member of the other team, interjected, "Wait. What? If you're doing point ten (.10), it’s the same as point one (.1)."

Adult5: "Let's see it one more time. When you press it, we'll just let it go. Okay."

Robot was tested.

Adult5: "So is it waiting for a specific amount of time or..."

E21 responded to Adult5 a little more assertively, "No. No. It…"

Adult5: "I want you to talk to your team."

Adult3 guided E21 by reminding him that he has team members willing to help, "Before you program and download, E21, talk to your teammates. Okay. Talk to them." E19 says something to E21 and makes a change on the computer.

E21 waves hand and says, "No don't put the zero. Only put the one." E21 was confident that they have tried placing a zero into the program without success.

Adult3: "Are you listening to your teammate?"

E21: "If we try to do a point ten (.10), every time we try to do that, it doesn't count the zero for some reason. It changes it to point one (.1). I went back to look at it and it said..."

Adult5: "Okay. Whenever you have a zero at the end of a decimal, you drop the zero."

E21: "Okay."

E19 suggested a change.

E21: "No, we're fine right now."

E21 did not have much to say during the researcher's first observation, but demonstrated confidence by speaking assertively to his team members and to two adults. During the focus group, E21 responded to a question if he thought he was a leader saying, "Sometimes I think others were more leaders. Towards the end I think I was more of a leader." Adult4 said, "He built his confidence. Are you a leader in [her non-core class]?" E21 responded, "not exactly." E21 was becoming more confident with robotics, reflected in how he spoke to his team members and the adults.

During the first and second observations, the researcher saw many examples of individuals who were maybe naturally confident quickly raise their hands, get out of their seats, grab the robot, grab control of a computer, speak confidently to youth and adults. During the third observation, the youth who had become knowledge experts took more of leadership roles and some of the originally confident youth took mostly subservient roles. For example, Z23 demonstrated a wide variety of situational leadership. If confident, she was the first to do something such as volunteer and work on the computer, but following is an example from the 3rd observation right before the challenge event:

> Z24: "Adult3 we made it close to the finish after stopping in the pause box."
>
> Z22: "Jumps up and down several times, we were really, really, really, really close."
>
> Z22 to Adult3 says, "We are really close."
>
> Adult3: "I know!"
>
> Z23: "Since they are close, I don't want to mess theirs up. I am afraid I'll mess it up."

Z23 was not as confident as the other team members were and was now willing to help and serve, but no longer took the lead.

In individual situations, all of the youth demonstrated individual leadership traits and behaviors such as confidence, initiative, knowledge, charisma, verbal skills, listening, respect, and supportive. Only a few showed a variety of leadership traits and behaviors. Following are two observations, the first from the researcher's first visit to the site and the second from the researcher's second visit to the site.

A1, A4, and B11 formed a group and began working. B11 started the computer, but then took the printed-out robot instructions and let A4 control the computer. A1 joined the group after walking around visiting others for eight minutes. B11 explained to A1 what they were working on. Within twenty seconds, A1 physically worked his way in between A4 and B11 even though he was standing. Adult2 visited the group, took the computer-controlling seat, and offered assistance demonstrating how to do the programming. After Adult2 stood, A1 quickly sat and now controlled the computer.

After 15 minutes of controlling the computer, A1 left the group and "table surfed" (jog up to table, jump-sit onto the table, allow momentum to slide on your rear end across the table). A1 quickly found a follower, B11, to whom he showed what to do. A1 and B11 took turns table surfing. Throughout the time period, A1 ended up showing and inspiring eight other youth to table surf, including A4. A1 occasionally walked around the room at which time A4 and B11 got very little accomplished. After one hour, A1 was no longer actively helping group.

During the second visit, the following observation took place demonstrating some growth of A1 (within a different group):

> A1 and A3 walked the track and discussed possible solutions. A3 returned to the computer. A1 visited D5, a member of a different team.
>
> Adult2: "Let's see what's going on here. What do you have so far?"
>
> A3: "We are building to…um".
>
> A1 returned from visiting D5 said, "I got it. I figured it out."
>
> Adult2: "You guys are doing the front part, right?"

A3: "Then we're going forward a little. Yeah. Then, A1, didn't you say we were going to backup and then…"

Adult2: "Okay. Seems like you have it under control."

A1 explained to Adult2, "I've been trying ... I've been going around to people".

Adult2: "To see how they do it, that's very good."

A1 explained a little more.

Adult2: "Right, right. We can learn from other people, that's right."

A1 then shared with A3 what he believed to be a possible solution.

During the first observed meeting, A1 demonstrated charisma and influence, but not much confidence with the technical aspects of the robot. As his confidence in the robot grew and he personally accepted the goal of getting the robot around the track, his leadership within his team grew.

Adult1 in the focus group stated, "The boys that were in here were many of the ones that if you asked their teacher about them they would be like, 'yeah he keeps me dancing during the day.'" A1 was frequently off-topic and acted silly, but he also exhibited many leadership traits and behaviors such as confidence, charisma, need for power, verbal skills, problem solving, supportive of others, influential, and persistence. During the focus group, A1 described himself as, "I am really never a leader. I am always second in command." The robotic challenge environment allowed his self-confidence, extraversion, charisma, creativity, and influence to appear as positive leadership as opposed to being a trouble-maker or second in command.

Leadership Development Through Technical Knowledge. Research tells us that intelligence is not a determining factor in leadership effectiveness, but having

situational knowledge is important to leadership (Bass & Bass, 2008; Murphy, 2011). In the Robotics Design Challenge there was a significant challenge. Because of the level of difficulty, the students with less knowledge and confidence began to look to the students, who they perceived as more knowledgeable, to be more of the leaders. The youth did not verbalize knowledge as a reason for decision-making and selecting leaders. The data for this theme is not grounded in quotations, but in the researcher making observations and analyzing why certain things happened. Following are brief summaries of the final six teams and a note about the team leadership and the researcher's observations of knowledge.

Team Beta had one leader dominate because of his technical knowledge. B9 frequently led the conversations and was the first to handle the computer or robot. During the focus group his responses included, "whenever I am organizing my group and team, I feel confident" and "whenever I was doing the programming, I was confident about it." Yukl identified self-confidence as an important personality trait of leaders and organizational skills as an important managerial technical skill improving the effectiveness of a leader (2010). B9's confidence in his technical knowledge motivated him to become a leader of his team (Avolio & Vogelgesang, 2011; Bass & Bass, 2008).

Team Gamma had four members that were not outspoken and through much of the event demonstrated mostly individualistic behavior including taking turns as opposed to working together. When asked during the focus group, three of the team members stated that they were leaders. When asked "how do you know you are a leader", the responses were "because I was honest and kind", "I am responsible and in control", and "I

notice what I do." None of the four differentiated themselves related to knowledge about robot building or programming. .

Three members of team Epsilon demonstrated knowledge helping them demonstrate additional leadership skills and behaviors. E20 was quiet and frequently absent, which hurt his overall personal development and collaboration with his team. His knowledge was respected though as he was chosen to demonstrate a math problem on the board and several times the adults encouraged the other team members to ask E20 what his thoughts were. During the focus group, Adult4 said, "he is not a leader at all in my class. He really shined in robotics."

During the first observation, E18, Z23, and E26 worked together. E18, although quiet, by the end of the meeting demonstrated the most leadership skills and behaviors, such as initiating conversation, controlling the computer, managing the roles of team members. By the third observation, she frequently came up with the programming ideas and led the assignment of roles during each test of the robot.

E21, described as shy by the adults, took over the programming by the midway meeting and the other team members would physically look to him before answering the questions adults were asking of the group. He was happy to work within the team, but the other members clearly expected his input when trying to figure out a problem.

E19 was confident and always one of the first to raise a hand during the first observation. During the second and third observations, E19 was still the first to do things, but his responses to inquiry were not always correct and his team members would not always let him implement his ideas. During the second observation, halfway through the

program, E19 was working in a different group, from the first observation. By the third and final observation, he was just hopeful to be involved:

> E19 says to E20, "do you want to start"
>
> E19: "I'll clap"
>
> Robot was tested and is not successful.
>
> E19 physically indicated that he wanted to do the clapping again.
>
> E21 interjected, "let me do it this time. We need to make sure it is right, then everybody can test it."

E19 wanted to be involved, but the other team members were gaining more knowledge and confidence around the various challenges and solutions, and his opportunities to help were fewer.

Knowledge or lack thereof also played a role for Team Zeta's four active and often vocal members. All four could have become strong leaders as they demonstrated good teamwork and everyone played important roles depending on the situation. Whether held back by knowledge or confidence, Z23 and Z25 by the end were happy to play supporting roles. Z23 stated, "I am afraid I'll mess it up" and Z25 said, "I don't know how to help." Z22 initially was quiet as may be his personality, but it seemed to reflect his limited confidence in the robots. As his confidence grew he became more outspoken. The leader of the group though was Z22's good friend, Z24. In the following dialogue, Z22 speaks up first, but allows Z24 to provide the more technical answer to the adult's question.

> Adult5: "Why don't you tell me about your program?"
>
> Four youth talk at once.

Adult3: "Let's have one person at a time."

Z22: "We made it to line A so far."

Adult5: "But what does your program mean? What is it telling you right there?"

Seven seconds go by with no answer.

Z24: "It's going to go forwards and it's going to turn right so that the front's here, then it's going to back up and use the touch sensor, and then it's going to turn left so that the front's here, and then it will go to here."

From the beginning, the other youth throughout the class and the adult mentors looked to Z24 for his knowledge and other positive traits and behaviors. Z24 had some prior robot programming experience, but as his knowledge grew during this program so did his confidence and frequency of speaking up and taking charge. Z24 could possibly have taken over, but his personality was team-oriented even helping the other teams several times. During the focus group, when asked if he was a leader in robotics Z24 replied, "yeah". When asked if he was a leader in other classes, Z24's responded, "not exactly." When asked why he is a leader in robotics but not other classes, Z24 responded, "because in robotics I help with the programming a lot."

Team Delta had three youth that worked well together and made incremental progress, but they could not solve the challenge of the entire maze and were frequently preoccupied with their personality conflicts with the one member, D5. D5 had the most prior experience and perceived knowledge, but he did not work well with the other members of the team. On the last meeting day before the challenge event, an adult mentor needed to say to one of the other team members, "You need to let control go. D5 has gotten you past the tape, around the corner, almost up to the box" and then just three

minutes later, "You have to listen. Let D5 be in charge. You support." During the focus group, D5 stated that he was the leader when, "programming, I knew what I was doing and I knew we needed lots of changes."

Team Alpha's leader, A1, led with charisma and extraversion. A1 was observed to be very social and occasionally "learned" how to do the programming and changing settings by visiting the other teams. He explained to Adult2, "I've been trying ... I've been going around to people". Alpha was mildly successful with the robot because A4, who rarely spoke even on this day, stepped up during the final team-meeting day. He added a lot of "measurement" code even though the teams were highly encouraged by Adult1 to use the various sensors instead, "Okay, you are getting points for sensors [not measurement]. You've got him running using measurements, now what?"

Leadership Development Through Teamwork. Teamwork or lack of teamwork showed levels of development and prominence of the leaders. Because of the age of the participants, group cohesion may have been difficult for the adolescents especially due to the challenging problem (Inhelder & Piaget, 2013; Klassen & Krawchuk, 2009). Yet, finding solutions to problems within a team is an important factor in leadership development (Covey, 1989; Redmond & Dolan, 2016). In the focus group Z25 said, "we had to listen to other people in our group instead of worrying about ourselves and only doing what we wanted to do with the robot." Adolescents experience leadership when they work as a team for the accomplishment of team goals (Yukl, 2010).

A major part of teamwork was assignment and fulfillment of team roles. Although most of the emphasis on roles came from the adults as will be discussed later in this chapter, occasionally a team member stepped up as in this example from team Epsilon:

Adult3: "I have a question before you start. How are you making sure that each person gets a turn?"

E21: "I am clapping first. E18 is programming first. E19 is starting, and we are rotating this way."

Adult3: "You have got an order. That sounds like a great plan!"

Team Zeta exhibited the most frequent and consistent team cohesion throughout the data gathering as demonstrated in the following three examples. The following dialogue occurred during the beginning of the second observation. It involves brainstorming because the focus of the meetings turned to the actual challenge track instead practicing individual sensors and small challenges.

Z25: "We can use the ultrasonic."

Z22: "Oh Z23 is supposed to be here. Sorry Z23." Z22 works on sketching out the track as Z23 repositions her chair to get closer to the group.

Z24: "Sound sensor for the pause."

Z25: "I was thinking more the light sensor for the pause. The ultrasonic sensor for boxes. We can clap it for the boxes and tell them to go up. Then clap again and make it go through…"

Z23: "The sound sensor? The ultrasonic sensor is seeing."

(indistinguishable chatter)

Z25: "I don't know if we could add the touch sensor since the touch sensors need to program everything backwards."

Z24: "We can't add the touch sensor because it won't do anything. We are supposed to turn without doing anything. That's why the sound sensor would be good."

Z25: "We can also use the ultrasonic sensor."

Z24: "The sound sensor would be best because we need to control when it turns and how long it stays in the pause box."

Adult3: "Good discussion going on over here."

Z25: "Yeah but the more sensors we use the more points we get. We need to get a ton of points to win. That would be fun. I want to win the first competition."

Z22: "We might miss program one of them and it mess up our whole entire thing."

Z23 says to Adult3, "What sensors are there?"

Z23: "Yeah but we are doing it in here."

Z25: "That's why we could try it."

Z23: "What other sensors are there?"

Team Zeta's dialogue demonstrated leadership traits and behaviors. Z25's enthusiasm and quick suggestions encouraged the dialogue to continue with creativity and strategy. Z22 helped everyone feel involved and provided a valuable opposing opinion to aid team decision-making. Z23 demonstrated good listening by echoing statements and asking important questions. Z24, often viewed by others as the leader, demonstrated listening skills and willingness to work with a distributive leadership team.

In this second example, the robot finished a test and the group returned to the computer to make changes. Adult5 joined the group and ends up conversing with Z25 as Z23 and Z24 helped Z22 as he controlled the computer.

Z24: "You're missing it."

Z22: "Oh there's another one!"

Z24: "No back this"

Z23: "This one!"

Z25 said something to Adult5

Adult5: "Would that be going backwards?"

Z25: "Oh."

Adult5: "Points for creativity."

Z24: "No. Don't select it. Drop it! No. Drop it!"

Z25: "We all should get an 'A' for effort."

Z23: "Drop it!"

Adult5: "Well I'm not the one who gets to grade."

Z25: "Aww."

Z24: "Wait. No. Change that."

Each team member was active and worked towards the betterment of the team leading Z25 to state, “We should all get an A for effort.”

The third example of Team Zeta included a confident Z22 attempting to change the assigned roles, but overall the exchange was friendly and respectful of the team concept. The robot was tested and something did not work. Z23 quickly walked to the computer and made a change while Z22 and Z24 continued to test.

Z22: "Something's making too much noise."

Z22 after a few moments says, "Let's go check our program out."

Z24: "We should change it from sound to…"

Z22: "What did you just do?"

Z23: "Nothing"

Adult3: "Okay guys talk with Z23. Tell her what the problem is and what your proposed solution is."

Z24: "Okay."

Z22: "Wait. Wait. Stop. Stop." Z22 placed a hand on computer keyboard.

Z22: "Let me see this." Z22 attempted to move the computer so that he could make changes to the program. Z23 quickly grabbed the computer. Z22 gave up control of the computer.

Z24: "Z23 is the programmer."

Z22 placed his hands on the computer keyboard again to type.

Z24: "Just tell her what to do."

Z23: "Just tell me what to do."

Z22: "Wait. I'm checking a few things okay?" After a few seconds and a pause by Z22, Z23 made a motion to gain back control of the computer.

Z22: "Okay wait. Okay wait. So, it goes forward, does this but ..."

Z23: "Move your hands!"

Z24: "Change it. On this. On this. On this." Z23 changed some settings in the program.

Z22: "No don't."

Z23: "I want to see what it does."

Z22 was gaining more confidence and wanted to fix the robot. He wanted to take charge and make changes himself. Despite the appearance of conflict in this dialogue, Z22, Z23, and Z24 continued to work as a team to make changes to the program's settings.

In other situations, teamwork was not always evident. During the focus group Adult1 reflected, "you try to set it up that they need each other to get to the goal, but by gum they will try to do it on their own no matter what. You will always have one or two at the table who really even though they want it to appear that they are working as a group they really aren't." The challenge situation and need to work as a team created an excellent opportunity for the development of leadership. The difficulty of the challenge was too much for one person to accomplish so teamwork was a must, but to be productive in certain situations, individuals often needed to step up. At the beginning of the last team meeting, Adult1 hoping to promote additional teamwork praised the group by saying, "Last week I was just complimenting you to Adult2. I said last week I saw so much teamwork, where people were saying, 'Wait a minute, that doesn't work. We can try this.' That's what we need guys."

Twenty minutes after her praise, team Gamma team cohesion broke down. G14 and G17 worked on a small part of the track and were not incorporating G15 and G16's part of the program or ideas. While G14 and G17 were at the track testing, G15 or G16 may have made a significant error in the program on purpose. Later, upon returning after testing the robot with the error, G14 and G17 were verbally upset. G15 said, "I didn't do it." Adult1 quickly understood the situation and went to talk to the group saying, "You are going to be very embarrassed on Saturday, unless the four of you decide to hunker

down and work together. You will not do well. I would like to see you work together. How can we make that happen?" Adult1 assigned G15 to be programmer saying, "You're going to be in charge of programming. I don't want to see anyone but G15 program."

Although some of the adolescents struggled with teamwork or specific team members, the individuals who thrived in this setting showed real leadership. Adult2 during the focus group said, "certainly leadership was developed with working as a team and having to accomplish something. I think that they understood the role that they had to have to advance their project." During the team meetings, Z24 embraced the team concept when saying, "Z23 is the programmer." Z22 placed his hands on the computer keyboard to type. Z24 stopped Z22 from taking over saying, "Just tell her what to do."

During the focus group, B12 twice mentioned responsibility and in response to how was she developing into a leader, her response was, "I got to work in a team and help them develop." Weeks earlier when B11 and B12 worked together on their half of the track, B12 showed patience and dedication to a team concept. Twice earlier in the hour, B11 had walked away from B12 to socialize with a different team. Both times B12 quietly and patiently retrieved B11 so that they could work together. For at least the third time in ten minutes, B11 was off socializing with others. B12 approached and told Adult1 of the situation.

Adult1: "B11, B11, what group are you working with? You should be over with your group."

B11 responded off camera.

Adult1: "Not if you are over there talking."

B11 and B12 returned to their computer and work together. After about 45 minutes, B11 begins to talk with others and not as much with B12. B12 demonstrated leadership traits and behaviors including the want to do the right thing regarding teamwork.

Leadership Development Through Problem Solving. The final major adolescent experience in the design challenge was problem solving. B9 responded to a focus group question about leadership development saying, "I do think these things develop leadership because, while we're doing it you try and work out the problems with your group. So you try to be a leader and help." Yukl identified problem solving as one of the four task-oriented behaviors of effective leaders (2012). The teams worked continuously in solving the problem of the day or the bigger get-around-the-track challenge. Rarely did the youth sit down and discuss their problem-solving thoughts, yet through observation, the researcher could see lots of trial-and-error problem solving and occasionally a deeper level as illustrated in the following examples:

Team Zeta was close to accomplishing one of the more challenging parts of the track. They had trial-and-error edited the settings of the program back and forth for a few tests on the track. Thirty seconds after the latest test, Z25 hit his forehead with his hand and excitedly blurts out, "I figured out our problem. There is nothing wrong with the program. It is my clapping, actually. I was clapping too late." Z25 stared at Z23, then redirected his attention to Z22 and Z24, "guys I have found our problem. There is nothing wrong with the program. I was clapping too late."

Another example of problem solving promoting leadership occurred after learning about the light sensor. The teams were confused when they would take the robots to the track for testing. It appeared that the robots and light sensors were not working. B9 and

B10 were returning to their computer from testing their bot when B9 placed his hand over the light sensor and the wheels stopped spinning.

B9: "Look at this. Look at this."

B10: "Oh it is..."

B9: "It must be too bright. Oh, it must be too bright."

B9 told Adult1 what they learned and tested the robot with their new knowledge. They returned to the computer a few moments later and changed the sensitivity of the light sensor.

Both research sites struggled with the use of the ultrasonic sensor, which works similar to sonar. In the following exchange during the researcher's first observation, the youth is very excited to share with the adults that her group had gotten the ultrasonic sensor to work by placing a hand in the way of the sensor as opposed to the box they were using:

Z23: "Those (boxes) aren't very hot. You have to use heat, that's an ultrasonic sensor, because you have to use heat."

Adult5: "So yes is your hand working when you do it because over there it wasn't working."

Adult4: "Does your hand work?"

Z23: "It did over there."

By the second observation, the midway point in the challenge-meeting schedule, most teams had decided not to use the ultrasonic sensor. Z22 was beginning to become more confident in his knowledge of the robot and had an idea of how to accomplish a task. He approached his friend and the "knowledge leader" of his team:

Z22: "Okay. So what do we need fixed?" There is no response, so after a few seconds…

Z22: "We need to fix this thing." There is no response, so after a few seconds…

Z22: "Okay. So we're not using the ultrasonic sensor." There is no response, so after a few seconds…

Z22: "You know we could use the ultrasonic sensor but it would be hard to do." There is no response, so after a few seconds…

Z22: "Do you guys think we should use the ultrasonic sensor?" There is no response, so after a few seconds…

Z22: "Do you think we should use the ultrasonic sensor?" There is no response, so after a few seconds…

Z24: "No that really doesn't work unless you put your hand in and I don't think at the competition they would let you put your hand in."

Z22: "Yeah." Z22 walks away from the group (returns after eight seconds).

Z23: "Of course they would."

Z22 was ready to solve a challenge using the ultrasonic sensor. Z24's own knowledge and problem solving thoughts determined that the ultrasonic sensor was not worth the time and effort to implement. Weeks later and a few days prior to the challenge event, Z25 hoped to figure out a way to get the ultrasonic to work to score better at the challenge:

Z25: "Shouldn't we have one of those sensors too? One of the ultrasonic sensors?"

Z24: "No we don't need one."

Z25 believing he had a solution to getting it to work stated, "But that would be cool. We would be able to more points by putting our hand in front of it."

Z24: "No."

Z25: "It's cool!"

Z24: "What points Z25?"

Z25: "If we add ultrasonic we could put our hand in front of it."

Z24: "That does not work Z25, so...That doesn't work very well."

Z25: "Please!"

Z24: "No."

Z25: "Please!"

Z24: "No."

Z25: "I don't trust you, come on let's just try it!"

Z24: "No, let's not try it, then we have to change the program, a lot."

Z25: "Then if it does work, we have to change the program. Ah come on, it would be points people!"

Z24: "Saturday is the competition. If we mess up, we wouldn't be able to fix it."

The adolescents experienced many aspects of leadership and leadership development during the meeting observations, after-event team meetings, and focus groups. Coding, data analysis, categorizing, and labeling led to four frequently recurring themes from the adolescent perspective: confidence, knowledge, teamwork, and problem solving.

Fostering Adolescent Leadership Development

A key research question sought to examine the role an adult mentor plays in fostering leadership opportunities for the Robotics Design Challenge participants. As the adolescents worked through the challenging hands-on activities, the five adult mentors

served a vital role in the success of the Robotics Design Challenge and the creation of an environment in which leadership development could occur (Redmond & Dolan, 2016). The two most common adult-mentor roles from the data were providing structure and feedback.

Structure. The Robotics Design Challenge necessitated an environment in which the youth were able to experiment with the hardware and software to meet the challenge. The adults needed to be willing to give up control of the learning environment, without sitting back letting the youth do whatever they wanted. The adults provided structure to place the youth in the best possible situation (Murphy, 2011; van Linden & Fertman, 1998). One example of providing structure was when adults performed minor behavioral adjustments such as sit here, throw trash away, clear your desks, put your chair away, be quiet, and stay focused.

Often the structure was more general and task specific. Each meeting, the adults had a plan of what the youth should accomplish. Adult5 provided structure for one meeting saying,

> You guys are going to be in 2 different teams.…You guys are going to get together and start brainstorming some ideas, maybe what sensors you want to use, maybe think about what sensors have been working really well. Which ones have you been having some problems with. Are you ready to get a basic idea of what your game plan is going to be for the competition?

The adult mentor is setting a structure for the brainstorming session by setting goals of which sensors to use and when. With additional guidance and feedback, the two teams

worked for almost an hour on brainstorming and planning including drawing a map of the track and placing sensors within the drawing at the planned usage locations.

Providing structure included encouraging communication, collaboration, and other forms of teamwork. In the following scenario, Adult5 wanted to ensure that everyone in a team had the same information and every member had an opportunity to participate. Four members of team Epsilon were discussing their ideas with Adult5. Adult5 noticed that E26 was writing something down and missed part of the discussion. Adult5 said to E19 "E26 was writing something down. Why don't you tell her what you have right now?" E19 explained what the group had recently decided to change in the plan and program. Team Epsilon spent a minute viewing the track as E19 and E21 explained the ideas. E20 had an idea and left to get his paper. He explained the idea to E19 and E21 without E26. Noticing the absence of E26, Adult5 asked the group to update the plan verbally to the team. E19 and E21 did most of the talking with E20 close by interjecting a few items. Adult5 noticed that E18 and E26 were still not involved much so she asked E21 to explain a small part of the track and then asked E18 and E26 to give ideas that led to additional collaboration.

At both research sites, the adults formed the individual teams. After several weeks of team meetings Adult1 provided structure and informed the youth of the assigned teams. During the explanation of the teams, Adult1 needed to provided additional structure of a disciplinary nature. Adult1 said,

> At this table here is G14, G15, G16, and G17…Excuse me, excuse me. (waiting for students to listen) Folks the more you chitchat, the less programming time you are going to have. All right, on your folder is a little yellow piece of paper and it

has the number of your team and it says front or back. Who can tell me what that is?

Several student confidently raised their hands, including D7.

Adult1: "D7."

D7: "Um."

Adult1: "Tell me B9?"

B9: "Um, it's telling them who is going to work on the front part or back part of the track."

Adult1: "You got it. Good. If you had a front on your folder, you are the front part of the track. If you have a back, you…could you guys please be quiet…If you have a preference that you would rather be front or back, you can trade pieces, but I want it on your folder."

Adult2: "Mutual, and mutually agreed to by the other person." As the adults were explaining this, D6 changed around his team's assignments.

Adult1: "D6, that's exactly what you don't do. Mutually agree. You guys have to think about the fact that Adult2 and I put these tags, we thought this through. Because these are the people we think would be the strongest to do these things. This wasn't just willy nilly. Do you understand?"

Most of the students responded, "Yes." Adult1 provided structure and discipline necessary to create an environment in which positive leadership development could occur. D6 was demonstrating leadership, but his actions were selfish and without regard for the team or the other members. By assigning teams and providing additional structure, the adult mentors are hoping for positive teamwork.

One important and common structure encouraged by the adults was the distribution of roles within the teams. The adult-mentors frequently made sure the teams were involving every member in some manner.

Adult5: "If you're starting you can't be the clapper."

Z24: "I will."

Adult5: "Z24, you are? Okay. Everybody has to take a step back. Okay. Z25 and Z23, since you guys aren't clapping; I want you to pay attention really closely so if it doesn't go well, you can tell me what you need to do."

Z25: "Start it." Z22 started the robot and quickly Z25 clapped when that was not his role.

Z24: "It's not you."

Adult4: "Do it again, Z24." Z22 started the robot and this time Z24 did the clapping.

Z24: "Okay. Okay. We got it in the wrong."

Adult5: "No. You're good because you want to use your touch sensor. It's not turning quite enough. Maybe turn a little more?"

The team tested the robot once more before returning to the computer to make programming adjustments. Adult5 allowed the youth to make their own decisions, but provided valuable structure encouraging each member to have a role during the robot test. Assigning roles became an important part of the teams eventually leading the adolescents to discuss their roles without the input of the Adults.

Since most of the students were new to the challenge event concept, providing structure by previewing the event would help the adolescents know what to expect. Both

teams spent time discussing various parts of the event. Adult3 prepared team Zeta for the competition saying,

> If you are at the competition and your robot has to be stopped and started again, how are you going to do that? You need to look organized, like you planned it. So you could start to have some roles that teammates like one person always starts, one person always claps, but then who is going to pick it up and move it if it has to be restarted again. Believe me it will have to be restarted again. I hate to say it, but very seldom do you have it go all the way around. So be thinking about that. However if Z24 wakes up with a horrible sore throat on Saturday and he cannot come, everybody on the team needs to be ready.

The adults wanted to make sure the youth had thought about and assigned roles, but that it was also important to be flexible and prepared to change the roles. Adult3 encouraged the youth to consider situational leadership that may arise from an absent team member or a robot not doing what was expected (Grint, 2005; Spillane, Halverson, & Diamond, 2004).

The adult-mentors provided structure throughout each of the team meetings. Much of the structure was making sure the youth were aware of what was happening that day and during the competition. Frequently the adults made sure the team members had a role in the current activities of the team.

Feedback. Feedback from the adult-mentors at both sites was prominent from the first team meeting through the final observation. For successful leadership development, feedback needs to be youth focused, specific, and of high quality (Mitra, 2005, Yukl, 2010).

The most frequent type of feedback was quick words of encouragement. Example phrases included "good idea", "good job", "good try", "great idea", "great job", "so close", "almost", "getting there", "way to go", and "keep trying." Feedback was immediate and robot-related.

Adult mentors also used inquiry questioning to encourage the adolescents to think about what they were doing in more detail. Example statements included "you checked", "which port", "which sensor", "more rotations or less rotations", "more sensitivity or less sensitivity", "what is the best angle", "is the robot going too fast for the sensor to work", and "how do we get the robot to do that."

In the following example, only two adolescents worked on the robot and at the time were having considerable difficulty. When testing on the track, the adult-mentor offered assistance.

Adult5: "Do you want me to put [my hand here]? I'll put my hand right here."

Z27: "I'll put my hand right here." [different location than Adult5]

E19 says to Adult5, "Make sure to kind of wave it to signal it to stop."

Adult5: "Okay, I will. I'll wave to the robot."

Robot was tested and was successful with this task.

E19: "Yes!"

Z27: "Yes!"

Adult5: "It didn't even touch, good job you guys."

Z27: "It took a long time but it was awesome."

E19: "We got it."

Adult5's conversation was light-hearted and the feedback shared in the excitement of success. Celebrating success was important to meeting the team members basic needs and encouraged them to "strive for even greater knowledge and understanding" (van Linden & Fertman, 1998, p. 27).

Even when something does not go as planned, the adults provided positive feedback and supported the youth with their excitement and specific statements (Redmond & Dolan, 2016).

Adult1: "Nice."

B9: "Wrong way."

Adult1: "Yeah, but that's not bad."

Adult2: "That's good."

Adult1: "That would be fabulous for it to back in like this and then go forward. That would be a great trick."

Adult2: "As long as you don't cross that black line."

Adult1: "Try it again. Try it again. B9, this is good." B9 tests the robot again.

Adult2: "Oh it said something."

B9: "Yeah, you get extra points if it says something."

B9 received valuable encouragement, relevant feedback, and multisource feedback from the adults who provided an environment in which B9's leadership could develop (Redmond & Dolan; Yukl, 2010)

In addition to the frequent and shorter statements of feedback, the adults also provided longer statements of feedback and encouragement. At the beginning of the last team meeting prior to the challenge event, Adult1 addressed the entire group saying:

> Now, you guys have the opportunity. You've got the skills. You've got the brains. You've had a lot of practice. I am expecting some of you to do pretty well. If any of us end up as the 35th team, or something, is that a bad thing? (most of the youth say, "No.")
>
> No, because the thing is, you guys have learned a new skill. You have learned how to program a robot. Now, whether you're the best in (name of county), or in (name of city), or in (name of state), that's not what matters. What matters is that you guys showed up to learn something new on your own free time, and that you should be really really proud of.

Sometimes the feedback from the adults was needed to lift the spirits of the youth. At the challenge event, one robot did not work well and did not respond when they changed the program. Two days after the challenge event Adult3 said,

> So team 1, I know it was disappointing. It was really hard as your teacher to see you so upset and some of you were crying…You are going to be in more things in life and they are going to turn out and people are going to clap and you are going to feel really proud. You are going to get an award. That time will come, even though Saturday it did not happen that way. I think we need to clap for team 1.

Class clapped for team 1. Comfortable in the environment created by the adults, E19 stepping up offering his perspective:

> E19: "If you guys were feeling sad about not getting an award. I know I felt a little sad. It was a privilege to get picked to be in a robotics competition or even in robotics and this is really you guys are all lucky to be in robotics."
>
> Adult3: "Yes that is a great perspective."

Z25: "You always learn from the mistakes you make."

The adult-mentors performed many roles during the Robotics Design Challenge. The two most frequently observed roles were to provide structure and feedback. Structure provided important direction to the process that was by nature open-ended. Feedback added to the structure in place to provide positive and negative statements to the youth so that they knew if they were progressing. Structure and feedback helped create an environment in which the adolescents could develop their own leadership skills and behaviors (Connaughton, Lawrence, & Ruben, 2003; Conner & Strobel, 2007; Kouzes & Posner, 2008; Yukl, 2010). In addition to identifying the observed roles of the adult-mentors, this research had the adults reflect on their experience and the experience of the adolescents.

Leadership Development Adult-mentor Perspective

The two adult-mentor focus groups provided an opportunity to reflect on leadership development during the Robotics Design Challenge. Even though the challenge was not designed to promote leadership development, it contained many aspects identified as having the potential for leadership development (Murphy & Reichard, 2011; Redmond & Dolan, 2016; Yukl, 2010). During the focus groups the adults were asked to reflect on leadership, leadership development, goals, teamwork, feedback, experiential learning, challenging problem, and variety of tasks. Analysis of the responses led to a focus on the experience as it presented a challenging problem and it caused youth to step-up and take charge.

Challenging problem. Adding challenge to an activity separates basic teamwork from opportunities that may develop leadership (Yukl, 2010). The foundation of the

Robotics Design Challenge was the idea that adolescents are learning new skills in the areas of math and science. The youth had to physically build and program a robot to perform tasks using sensors. Except for a few of the youth, everything they were learning was new and challenging. Adding to the math and science skills, the concepts of teamwork and the difficulty of the tasks created an activity that challenged all of the youth. Although teamwork was involved from the very beginning, Adult2 observed, "Their investment increased when they realized it was on them to figure things out" as opposed to being told how to do everything.

Not all activities develop leadership. The Robotics Design Challenge created an environment in which adolescents needed to work together to solve a difficult challenge. Adult2 reflected on the necessity to work with others:

> Whether we call it a competition, challenge, or something, I think that does give the opportunity for people to develop leadership roles as opposed to something where everybody is independent like if we are learning aerobics or something. There has to be... an ultimate goal that you are working together as a team to accomplish.

Adult1 discussed how in her classes students complete mini-challenges almost daily, but she would not consider them to be leadership development. She then addressed the level of difficulty in this activity:

> I do think that this challenge is big enough that it does put some doubt in their mind of whether they could do it by themselves…. I think it is more the insecurity that a bigger challenge creates. That leads to the leadership [more] than just any challenge.

Since leadership development occurs over time as adolescents experience authentic opportunities, it is difficult to pinpoint exact leadership development. Adult1 provided one possible example, "I do think that the more challenging the problem, the greater the chance that people will ask for help and look to each other for help, which eventually leads to leadership." Yukl wrote a similar reflection; challenging situations help development by requiring managers to "try out new behaviors, learn new skills, and develop a better understanding of themselves" (2010, p. 467).

Adult3 said, "To have a leadership experience it is going to have to be hard. We can't just hand it to them. The more challenging, the more good they are going to feel about themselves." The adolescents experienced an authentic opportunity different from their normal school environment. Adding challenge to the authentic opportunity led individuals to exhibit leadership traits and behaviors they may not exhibit in other situations (Hersey & Blanchard, 1982; Starrat, 2001).

Adult3 and Adult4 talked about how the challenge and success built confidence in individual youth and that confidence led to the individuals to take charge in situations (Bush, 2003; Murphy, 2011). For example, Adult4 said, "E20, he is not a leader at all in my class. He really shined in robotics." Adult3 replied, "Last year he was apprehensive in my class, at times he did not understand." Adult4 finished with, "He had a lot more confidence [in robotics]."

Working as a team and solving a challenge may build a person's confidence, but for leadership development, there must still be more. Adult2 described another step in the development process, "We did from time to time see that when one figured something out

and they would share the information. That was certainly interesting and a positive development." Adult1 specifically mentioned leadership in saying:

> We saw the most leadership when the light bulb went off for one kid they wanted to show it off to everybody and when they did that sparked new interest which led other kids to go off, but it took that one kid to figure it out.

As an example Adult1 described one situation involving the adults, "We truly got excited about it, impressed with what they were doing. Two girls really got it and really liked the fact that we didn't know how to do what they knew." Adult2 added, "They were figuring out stuff that adults did not understand." Adult1 finished, "That led them to say let me show you how to do this."

The challenging problem led to adolescents working hands-on as teams. Success led to confidence and sharing knowledge and skills with other people. The difficult challenge led many of the adolescents to exhibit traits and behaviors of leaders including taking charge.

Taking charge. Confidence and assertiveness are two traits commonly associated with leaders (Bass & Bass, 2008; Murphy, 2011). This report included youth confidence examples in other sections. From the perspective of the adult mentors, a different term arose. The adults looked for youth to show persistence and determination and to take charge (Redmond & Dolan, 2016).

Regarding the challenge and the need for adolescents to work in teams, Adult2 said, "Within teams, you will have people step up and take charge because they see something. I certainly think it is a valuable way to learn leadership that school generally doesn't give you an opportunity." In a nod to situational and distributed leadership

theories, Adult2 later added, "There were…lessons learned by all of the kids being in a team environment. Someone has to take charge for a while, but they could take turns."

As the day of the challenge event approached, some youth who previously resisted stepping up became more involved in their groups. Adult1 reflected on A4 being more active during the last meeting:

> The thing that astounded me. A4, he appeared, for most of the weeks…, to be there because his parents made him come. He seemed to have absolutely no interest in it. He was always doing something else. But when it came down to the wire by gosh he got that team through a couple very sticky situations. I was thinking why didn't we get him leading earlier.

By the second researcher's observation, midway through the team meetings, E21 was stepping up and becoming more active. Adult4 described the difference between E21 in robotics and in a regular class environment:

> In [Adult4's class, E21] is very shy, never talks, he is very shy, but in robotics Mr. Aggressive, he was the leader. He ran his group. In [subject area] he would never. If you observed my class, you would see a whole different kid. He is not aggressive; he is very shy and withdrawn. I saw a whole new kid."

A few minutes after describing E21 as above, E21 came over to the adult-mentor focus group where the following dialogue occurred:

> Adult3: "Do you think you were a leader in robotics?"
>
> E21: "Most of the time. Sometimes i think others were more leaders. Towards the end I think I was more of a leader."
>
> Adult3: "What made you develop into more of a leader?"

E21: "I kind of thought everybody was looking towards me when they wanted something done that they could not figure out how to do because they thought i knew more of it."

Adult4: "He built his confidence. Are you a leader in [Adult4's class]?"

E21: "Not exactly."

Adult4: "In my class you are quiet and good... I saw you become a leader in robotics. That was good. I liked it."

E21, bolstered by his level of technical knowledge and increasing confidence, took charge when needed. He was not the only one to exhibit traits and behaviors different than the adults were used to seeing. Following constructivist principles, it is important to view individual situations and people. Following are brief views of three adolescents identified by the adults as having demonstrated traits and behaviors different from the normal classroom environment.

E18 was a leader depending on the situation. During the first observation within a team of all girls, she spoke up frequently, controlled the computer and robot at least half of the group time, and was observed assigning roles during the robot testing. After joining a group with ascending leader E21, she was not as outgoing during the second observation. Adult3 said the following about E18, "[She] developed more especially towards the end, especially with our pushing. She was intimidated by E21." During the focus group, E18 joined the adults when the following dialogue took place:

Adult3: "Would you describe yourself as a leader in your team."

E18: "Um...all of us kind of were leaders."

Adult4: "How about you?"

E18: "Um…I don't like being… I am not sure which one it is."

Adult4: "Were you a leader? Were you a follower? Were you a team captain?"

Adult3: "Being a team leader is okay. You can say it."

E18: "Uh okay. I guess I was a leader."

Adult4: "She was a leader during the building part."

E18: "I helped out with the programming."

E18 was active throughout all of the team meetings. She occasionally allowed others to lead and be more vocal, but she was always on-task and ready to help. Her style of leadership was not as aggressive as E21 and her confidence needed to reemerge when placed on the same team, but E18 and E21 were successful leaders for team Epsilon (Bass & Bass, 2008; Hoyt & Johnson, 2011).

Adult4 identified another youth as an emerging leader, "Z22 is very shy, but he was a strong leader." Z22 during the first team meeting observation did not talk very much except with Z24. Adult3 said, "He very much was a change in personality." Adult4 agreed by saying, "He is very quiet in my class very well behaved." Later in the conversation, Z22 visited the adult-mentor focus group and Adult3 reiterated, "He knows his stuff, he knows the answers, but is very quiet." Adult4 added, "He is very quiet, he is not a leader [normally]."

Z25 missed the first team meeting observation, but from the beginning of the second team meeting observation, it was clear that he was very verbal. During the focus group, Adult4 said, "Z25 is a behavior issue in my class big time, but he is proud of himself in robotics." Adult3 added, "He started off as a behavior issue [in robotics], but

not so much lately." At the other research site, Adult1 described some of their behavior-issue participants as follows:

> A number of the kids in this program are some of your problematic kids in classes…. They want things that challenge them….The boys that were in here were many of the ones that if you asked their teacher about them they would be like, 'yeah he keeps me dancing during the day.' It is because they want authentic problems.

Adult4 continued, "[Z25] is definitely not a leader in [Adult4's] class." In reflecting on the robotics-design-challenge experience, Adult4 said, "it is going to give him more confidence in other areas. He does not have confidence in my class."

Conclusion

Within the scope of the developing themes of this research project there were some commonalities and differences between adolescents and adult-mentors and also between the two research sites. In analyzing the data, there were enough similarities to consider narrowing the focus of this report to fewer themes, but doing so seemed to limit the impact of the individual experience, as constructivist theory was identified in the proposal and in the data. The actions of the adults were very important in creating an environment in which the adolescents could be successful and leadership could develop. The experience of the adolescents was more segmented and individualistic. Adults were able to focus on creating the structure and providing current feedback and assistance. At any one given time, individual adolescents may have been experiencing confidence or lack thereof, knowledge or lack thereof, teamwork or lack thereof, and ability to problem-solve or lack thereof, in addition to other experiences.

The two research sites were similar in demographics, structure, and overall implementation. The greatest differences were the third adult-mentor and the ratio of adult-mentors to adolescents. The third adult-mentor attended the first half of her site's team meetings. The third mentor had technical knowledge that the other four adult-mentors did not. That knowledge helped create a more confident atmosphere, but may not have directly affected the results. The ratio of adult-mentors to adolescents was possibly a bigger factor. One site had 17 youth and two adults compared to 11 youth with 3 adults. With 17 youth, the adults were able to provide assistance as needed, but the adults with 11 youth were able to take a more proactive stance possibly providing more structure and feedback.

Summary

This phenomenological study explored the leadership development experiences of adolescents participating in the Robotics Design Challenge sponsored by the University of Missouri Engineering Department. The study gathered and analyzed qualitative data exploring leadership development as experienced by adolescent participants and adult-mentors of the Robotics Design Challenge. Five leadership development experiences emerged for adolescent participants: authentic opportunity, mentor access, amount of challenge, variety of tasks, and quality and acceptance of feedback. Four leadership traits and behaviors surfaced as being most important from the adolescent perspective: confidence, knowledge, teamwork, and problem solving. Two adult-mentor roles were providing structure and feedback. Analysis of the adult's description of leadership development led to two themes: a challenging problem and youth taking charge.

The Robotics Design Challenge along with the adult mentors created an authentic learning environment that led adolescents to exhibit traits and behaviors of leaders. Within the given structures, adolescents learned and practiced new knowledge and skills gaining confidence as they worked to solve challenging problems.

Discussion

The purpose of this phenomenological study was to explore the leadership development experiences of adolescents participating in the Robotics Design Challenge sponsored by the University of Missouri Engineering Department from January 2015 to April 2015. This study utilized qualitative research principles guided by constructivist theory allowing for emergent design. This study sought to identify leadership development experiences and learn how adolescents and adult-mentors experience and describe leadership development.

Using qualitative methods, this research project explored adolescent leadership development. Observations from two research sites, team meetings, adolescent focus groups, adult-mentor focus groups, after challenge event debriefings, and documentation provided rich data, which was analyzed from a phenomenological perspective. Data analysis combined with existing research results led to the emergence of the findings outlined in this dissertation adding to existing literature in the field of adolescent leadership development and potentially the construction of adolescent leadership development theory.

Emerging Leadership Development

Participation in the Robotics Challenge provided insights into the emergence of leadership skills and development among adolescents. The adolescent participants experienced authentic opportunity, mentor access, amount of challenge, variety of tasks, and quality and acceptance of feedback. Each adolescent experienced the opportunities differently causing a variety of responses (Greenfield, 1984; Hermes, 1999; Starrat, 2001).

Authentic opportunity was the real-life challenge that necessitated working as a team to solve the challenge. Individuals needed to verbalize ideas, work collaboratively, physically manipulate the hardware, edit the computer program, analyze the situation, and solve a problem. Having this authentic opportunity forced the individuals either to lead or to follow during each situation.

The adult mentors frequently verbalized the group goals, provided technical instruction, created a structure for success, used inquiry-learning techniques, answered questions, and motivated with general and specific feedback. The adults were not simply supervising the students they were actively contributing to the success of the teams and the potential development of leadership.

Separately the challenges of learning a new skill, analyzing success or failure of frequent robot tests, creating solutions to address the Robotics Design Challenge, and dealing with adolescent-team dynamics, may not have resulted in leadership development. When those events are all occurring at the same time, and within a given time frame, the leadership development opportunities surfaced. Some youth embraced the challenge and exhibited leadership traits and behaviors they do not normally display in other environments.

Tasks in the Robotics Design Challenge included building, programming, data entry, testing, analyzing, problem solving, communicating, collaborating, starting, clapping, transporting, recording, and more. The leadership-development-concept variety of tasks normally speaks to the idea that a leader needs to know the challenges the subordinates face to be an effective leader. Within this challenge, these tasks created

multiple opportunities of the adolescents to step forward and become a leader if even for a brief moment depending on the situation.

Frequent feedback from the adults was important to keep adolescents motivated and on-task in reaching the short-term goals. The direct feedback helped create a large percentage of on-task time and helped lift spirits when the challenge was weighing down spirits.

Implications for Practice. The Robotics Design Challenge possessed opportunities for the youth to demonstrate leadership traits and behaviors and develop leadership. Because the authentic opportunities existed naturally, nothing extra was needed to ensure the opportunities. The presence of the opportunities allowed the program, adults, and the youth to encourage the development of leadership. Options for future practice include providing leadership training, encouraging leadership traits and behaviors when they occur, reflecting on leadership opportunities, and implementing structure that enhances the leadership development opportunities.

Leadership Development Among Adolescents

Four leadership traits and behaviors surfaced as being most important from the adolescent perspective: confidence, knowledge, teamwork, and problem solving. Traditionally introverted adolescents do not experience many opportunities to develop leadership (Reichard et al., 2011). It was great to see some adolescents rise to leadership roles based mainly on their increased knowledge and confidence. Conversely, some adolescents demonstrating leadership during the early meetings did not demonstrate as much leadership in the later meetings as their individual confidence or level of knowledge were surpassed by other youth.

The first and most prominent trait visible in the researcher's observations was confidence and lack of confidence. Several youth were very active during direct dialogue with the adult mentors. This activity reflected a high level of confidence and likely interest in the activities. Unfortunately, some students never volunteered answers and demonstrated confidence in working with the robots or within the teams. "Extraverted individuals who are loquacious, assertive, and energetic are seen as effective leaders more often than individuals who are introverted, quiet, and shy" (Kudo, Longhofer, & Floersch, 2012, p. 353).

Because of the level of difficulty, the students with less knowledge (or self-confidence) began to look to the students, which they perceived had more knowledge to be more of the leaders. Both research sites spent several team meetings early in the process covering the basics of the robot, the sensors, and the programming. Adolescents who grasped the programming concepts and skills the best became the de facto leaders of their teams as they gained more knowledge and confidence.

Teamwork or lack of teamwork showed levels of development and prominence of the leaders. Many of the adolescents demonstrating confidence and knowledge were also aware of the importance of teamwork. Adolescents demonstrating the most leadership were frequently the best team members as well. There was a considerable amount of individual work as well. Adult1 observed that what might appear to be teamwork is not always teamwork, "You will always have one or two at the table, who even though they want it to appear that they are working as a group, they really aren't. They are trying to get the rest of the group to do it their way." Some of the adolescents were so focused on

the challenging task that even though they were working with others, they were not working as a team.

The teams worked continuously in solving the problem of the day or the bigger get-around-the-track challenge. Team member conversation and collaboration led to solving the at-the-moment problems. The adolescents demonstrating a level of leadership during problem solving were the ones to verbalize their ideas the most. Except when forced to do so by the adult-mentors, the youth did not sit down as a group to solve the problems. The quick trial-and-error nature of the activity made it important for the youth to stay on task or the team would pass them by. Some of the youth demonstrated leadership, by making sure the other team members were involved in the problem solving.

Implications for Practice. The adolescents demonstrating leadership traits and behaviors were strong in four areas: confidence, knowledge, teamwork, and problem solving. Both sites focused on increasing knowledge the first few weeks of the team meetings. After that point, the focus turned to the actual track. Because of the lack of organized knowledge development later in the challenge, the knowledge leaders were the individuals who gained the knowledge the quickest. To improve the possibility for leadership development, knowledge attainment and knowledge sharing could have been encouraged throughout the team meetings. Continued develop of robot concepts and skills could have increased the confidence of some and kept confidence high in others. In addition, with increased knowledge and confidence, teamwork could improve. Team members would have more confidence in the others and allow others to have greater roles within the team.

Instruction in and a focus on teamwork would be beneficial. The adolescents demonstrating the most leadership development demonstrated a decent level of teamwork, but the overall structure and implementation of teamwork could have improved. With more knowledge and confidence and improved teamwork, the level of and ability to problem solve would improve lessening the need for trial-and-error.

Could the teams have done better if they spent less time actually working on getting the robot around the track, as was the challenge? Spending more time on programming skill development, teamwork skills, and problem solving skills may have increased the quality of efforts when working to get around the track. In addition, focusing on things such as brainstorming, planning, knowledge sharing, and reflecting on the process may have improved the efficiency of the teams. Care must be taken when implementing these ideas as to not hurt the motivation of the adolescents. As expressed in the following dialogue, the motivation of the adolescents may have improved once they were working on the actual track. Adult2 said, "Once we had a maze, people got more interested….When they saw the physical maze…" Adult1 finished the thought with, "then they got it."

Fostering Adolescent Leadership Development

The third research question sought to examine the role an adult mentor plays in fostering leadership opportunities for the Robotics Design Challenge participants. The adult-mentors did an excellent job throughout performing many roles, but two factors affected the possibility for leadership development the most: providing structure and feedback. Providing structure is an important part of managing individuals and organizations (Barker, 1997). In the structured business-world, organizations provide

mentoring situations providing regular feedback to assist individual development (Hernez-Broome, Hughes, & Center for Leadership Development, 2009; Rhodes & Lowe, 2008; Yukl, 2010).

The adults provided structure to place the youth in the best possible situation including, rules, goals, team formation, role creation, discipline, and troubleshooting. Both sites created an environment that was different from a traditional classroom that may have appeared to be chaotic but still had a firm structure keeping the adolescents on task. Both sites experienced adolescents who normally do not lead exhibit leadership traits and behaviors.

Frequent feedback included quick words of reassurance and also quick robot-related statements and questions meant to encourage the adolescents to think about what they were doing in more detail. Several times adolescents went out of their way to share a success or something learned with the adults to receive positive reinforcement. Only a few times, youth were observed providing positive feedback to other youth.

Implications for Practice. The structure provided was great. Unfortunately, the adults were so focused (as were the students) on getting the robots to go around a track that they may have missed opportunities for other areas of development. Spending more time on leadership development, programming skill development, teamwork skills, problem solving skills, brainstorming, planning, knowledge sharing, and reflecting on the process may have provided additional structure that may have led to increased personal development as well as greater team success. Powless, Steinfeldt, and Beebe described the need for providing time for adolescents to think critically in applying material they learn (2017).

During the focus group, Adult3 astutely reflected that providing feedback "would be something interesting to teach at the beginning, is how do you give feedback to the team. We could teach a few phrases." Adult4 followed with, "This is what you would say." Adult3 lamented, "We kind of did the opposite - don't say." Encouraging the adolescents to praise one another may have improved communication. Teaching how to give effective feedback may have encouraged the adolescents to reflect on the process and themselves sparking personal development.

Leadership Development Adult-mentor Perspective

Research question four sought to learn how adult-mentor participants describe leadership development experiences in the Robotics Design Challenge. Analysis of the adult's reflection of leadership development led to two themes: a challenging problem and youth taking charge.

The Robotics Design Challenge created an environment in which adolescents needed to work together to solve a difficult challenge. A challenging problem by itself may not lead to leadership development, but when supported with the structure and feedback of mentors, some adolescents displayed traits and behaviors that they normally do not have the opportunity to exhibit. Adult1 and Adult2 discussed several after-school activities and pointed to the challenging problem as the factor that separated the Robotics Design Challenge as an opportunity that provides an environment in which to practice leadership.

Confidence and assertiveness are two traits commonly associated with leaders. During the focus groups, the adult mentors reflected on adolescents that took charge of situations as examples of leadership. The Robotics Design Challenge and the adult

mentors created an environment that needed youth to take the lead so that the teams could solve the challenge.

Implications for Practice. Talking about leadership is not good enough if the goal is to develop leadership. Adolescents can develop leadership and having a challenging problem is important, as the youth need to work together and experience situations in which individuals need to take charge. Many people are more than willing to sit back and be a follower. The Robotics Design Challenge provided an environment in which some followers became situational leaders. Providing adolescents additional challenging problems and more opportunities to take charge will possibly lead to greater leadership development.

Limitations

This research project could not fully account for the many concepts and theories related to leadership, leadership development, and adolescent development. The three-month period provided adequate time to observe leadership development within the context of this study, but did not provide enough time to factor in the many additional concepts and theories that may also apply to the situation. In addition as in many short-term studies, the long-term effects are unknown.

Triangulating Data strengthened validity. One significant portion of data came from the focus-group discussions of adolescents who may not be able to reflect on events and communicate their responses completely. The design of the focus group received extra planning to ensure that the time was valuable to the researcher while still being a positive experience for the adolescents. Despite the extra care taken, many of the

adolescent responses were very brief and were similar to one another. Although brief, the results did reflect the previously observed traits and behaviors.

The developmental readiness of the participants may have affected the data. Although the data was strong and allowed for the development of definite themes within this study, numerous leadership traits and behaviors previous identified by researchers were not observed.

The data collected was noteworthy, but the sources were limited. Although one research site was urban and one was rural, the demographics of the participants were very similar and differences did not appear to affect this study. Future larger studies may want a greater variety of research sites.

Selecting an activity, not designed to develop leadership, generated data that was unique, but also possibly limiting. Throughout the observation process, the researcher could identify leadership development opportunities and wonder if-only the participants were aware of the possibilities for leadership. How would incorporating leadership development concepts and structure affect the Robotics Design Challenge and similar research? One could believe there would be greater leadership development. Would time spent on leadership development lead to greater success within the robot challenge or would the time spent detract from the Robotics Design Challenge?

Recommendations for Future Research

Based on the findings and limitations of this study, the researcher offers the following recommendations for future research:

- Conduct studies on adolescents who participate in multiple activities that may develop leadership. This study focused on one activity. Leadership development is a

lifelong process spanning many development opportunities (Brungardt, 1997). What is the impact of an adolescent participating in multiple activities? What is the impact of an adolescent participating in multiple activities that span longer time periods?

- Conduct studies on adolescents who participate in leadership development activities to determine the impact of the participation on other areas of the participant's life. Are adolescents able to transfer traits and behaviors learned in one setting and exhibit similar traits and behaviors to other situations? Some adult mentors in this study wondered if confidence gained throughout this program would translate to school classes or other areas of life.
- Conduct studies on adolescent participants of challenges when part of the challenge includes training and expectations-for-implementation of leadership, and/or teamwork, and/or providing feedback. This study included leadership, teamwork, and feedback, but there was no evidence of training the adolescents in these areas. Would challenge-event participants be more successful with training in leadership, teamwork, and/or feedback?
- Conduct studies on adolescent leadership development programs. In recent years, programs that teach leadership concepts have become increasingly common in elementary and middle schools. Research would help determine the benefits of such programs and create implementation best practices for increased effectiveness.

Summary

This phenomenological study explored leadership development experiences of adolescents participating in the Robotics Design Challenge sponsored by the University

of Missouri Engineering Department. Leadership development includes experiences which promote attainment and growth of leadership traits and behaviors.

The concepts of constructivism, subjective leadership, and situational leadership encouraged the researcher to try to understand the experience of each individual within a variety of situations. Most of the adolescents demonstrated leadership traits and behaviors a few times. From the first observation it was obvious that even within a relatively homogeneous group, each individual experienced the events slightly differently. Even during shared situations, adolescents responded differently and occasionally differently from the individual's previously observed behavior.

The robotics challenge event provided leadership development opportunities which emerged from the amount of challenge, mentor access, variety of tasks, and quality and acceptance of feedback (Yukl, 2010). The adolescents learned building and programming skills and were challenged to put the skills to work by solving a difficult culminating task. With access to and feedback from adult mentors, the youth were able to experience a variety of leadership opportunities.

Within the challenge environment, the adolescents experienced leadership opportunities in a variety of situation. Four themes that best illustrated the adolescent perspective were confidence, knowledge, teamwork, and problem solving. As some of the youth became more knowledgeable and confident in their abilities, then were more involved in helping their teams solve the daily problems.

The adult-mentors served an important role in fostering an environment in which the adolescents could develop leadership traits and behaviors. When the adults provided structure the adolescents were able to focus on the daily tasks and were able to

individually develop. Frequent feedback from the adults helped keep each youth on task and motivated to continue to work to finding solutions.

During the focus groups, the adult mentors described the potential for leadership development frequently providing examples of the adolescents experiencing the high level of challenge and stepping up to take charge within their teams. The adults pointed out how the robotics design challenge led to adolescent traits and behaviors different than those displayed in a normal classroom. Adolescents stepped up either verbally or physically to help their teams make progress in meeting the daily challenges.

Conclusion

Leadership development opportunities are possible in many activities. The environment of the robotics design challenge encouraged adolescents to work in teams completing tasks that were too difficult for one individual within the allotted time. Adult-mentors provided structure and feedback that allowed the adolescents to learn and grow as potential leaders. The structured team environment and level of challenge led many of the adolescents to exhibit leadership traits and behaviors that they may not normally exhibit.

References

2014 MU Annual Robotics Challenge (n.d.). Retrieved September 10, 2014, from http://engineering.missouri.edu/neuro/files/MU-Annual-Robotics-Challenge-2014.pdf

9th Annual Robotics Design Challenge (n.d.). Retrieved September 10, 2014, from http://engineering.missouri.edu/neuro/outreach/robotics-design-challenge

Avolio, B. J. & Hanna, S. T. (2008). Developmental readiness: Accelerating leader development. *Consulting Psychology Journal, 60*, 331-347.

Avolio, B. J. & Vogelgesang, G. R. (2011). Beginnings matter in genuine leadership development. In S.E. Murphy & R.J. Reichard (Eds.), *Early development and leadership: Building the next generation of leaders*. New York: Psychology Press/Routledge.

Barker, R. A. (1997). How can we train leaders if we do not know what leadership is? *Human Relations, 50*(4), 343-362. doi:10.1177/001872679705000402

Bass, B. (1989). *Stogdill's handbook of leadership: A survey of theory and research*. New York: Free Press.

Bass, B. (1990). From transactional to transformational leadership: Learning to share the vision. *Organizational Dynamics, 18(3),* 19-31.

Bass, B. & Bass, R. (2008). *The Bass handbook of leadership: Theory, research, and managerial applications, 4th edition*. New York: Simon and Schuster.

Baumrind, D. (1991). The influence of parenting style on adolescent competence and substance use. *Journal of Early Adolescence, 11*(1), 56-95.

Blake, R. & Mouton, J. (1985). *The managerial grid III: The key to leadership excellence.* Houston: Gulf Publishing Co..

Bolman, L. G. & Deal, T. E. (2008). Reframing organizations: Artistry, choice, and leadership. San Francisco, CA: Jossey-Bass.

Brungardt, C. (1997). The making of leaders: A review of the research in leadership development and education. *Journal of Leadership & Organizational Studies, 3*(3), 81-95.

Bush, T. (2003). *Theories of educational leadership and management* (3rd ed.). Thousand Oaks, CA: Sage.

Christman, D. & McClellan, R. (2008). "Living on barbed wire": Resilient women administrators in educational leadership programs. *Educational Administration Quarterly*, *44*(3).

Connaughton, S.L., Lawrence, F.L, & Ruben, B.D. (2003). Leadership development as a systematic and multidisciplinary enterprise. *Journal of Education and Business*, 46-51.

Conner, J. O. & Strobel, K. (2007). Leadership development: An examination of individual and programmatic growth. *Journal of Adolescent Research, 22*, 275 - 297.

Cooper, D.L., Healey, M.A., & Simpson, J. (1994). Student development through involvement: Specific changes over time. *Journal of College Student Development*, *35*, 98-102.

Covey, S. R. (1989). *The Seven Habits of Highly Effective People.* New York: Simon and Schuster.

Creswell, J. W. (2007). *Qualitative inquiry and research method: Choosing among five approaches* (2nd ed.). Thousand Oaks, CA: Sage.

Creswell, J. W. (2009). *Research design: Qualitative, quantitative, and mixed methods approaches* (3rd ed.). Thousand Oaks, CA: Sage.

Creswell, J. W., & Plano Clark, V. L. (2007). *Designing and conducting mixed methods research*. Thousand Oaks, CA: Sage.

Creswell, J. W., Plano Clark, V. L., Gutmann, M., & Hanson. W. (2003). Advanced mixed methods designs. In A. Tashakkori & C. Teddlie (Eds.), *Handbook of mixed method research in the social and behavioral sciences* (pp. 209-240). Thousand Oaks, CA: Sage.

Culp, K., & Cox, K. J. (2002). Developing leadership through adult and adolescent partnerships in the third millennium. *Journal of Leadership Education*, *1*(1), 41-57.

Day, D.V. (2004). Leadership development. In G. Goethals, G. Sorenson, & J. Burns (Eds.), *Encyclopedia of leadership*. (pp. 840-844). Thousand Oaks, CA: SAGE Publications, Inc.

Deutsch, N. L. & Spencer, R. (2009). Capturing the magic: Assessing the quality of youth mentoring relationships. *New Directions for Youth Development*, 121, 47-70.

Dubois, D. L., Holloway, B. E., Valentine, J. C., & Cooper, H. (2002). Effectiveness of mentoring programs for youth: A meta-analytic review. *American Journal of Community Psychology, 30*(2), 157-197.

Fertman, C. I. & van Linden, J. A. (1999). Character education: An essential ingredient for youth leadership development. *NASSP Bulletin, 83*(9), 9-15.

Gill, S. J. (2010). *Developing a learning culture in nonprofit organizations*. Thousand Oaks, CA: SAGE Publications.

Gottfried, A. E. & Gottfried, A. W. (1996). A longitudinal study of academic intrinsic motivation in intellectually gifted children: Childhood through early adolescence. *Gifted Child Quarterly, 40*(4), 179-183.

Gottfried, A. E., & Gottfried, A. W. (2011). Paths from gifted motivation to leadership. In S.E. Murphy & R.J. Reichard (Eds.), *Early development and leadership: Building the next generation of leaders*. New York: Psychology Press/Routledge.

Gowers, S. (2005). Development in adolescence. *Psychiatry, 4*(6), 6-9.

Greenfield, T. B. (1984). Leaders and schools: Willfulness and nonnatural order in organizations. In T. J. Sergiovanni & J. E. Corbally (Eds.), *Leadership and organizational culture: New perspectives on administrative theory and practice* (pp. 142-169). Urbana, IL: University of Illinois Press.

Greenleaf, R. K. (1977). *Servant leadership: A journey into the nature of legitimate power and greatness.* Mahwah, NJ: Paulist Press.

Grint, K. (2005). Problems, problems, problems: The social construction of 'leadership'. *Human relations*, *58*(11), 1467-1494.

Guided Inquiry. (2015). Retrieved July 24, 2018, from https://mcds.dese.mo.gov/guidedinquiry/District and Building Student Indicators/Building Demographic Data.aspx

Haensly, P. A., Lupkowski, A. E., & Edlind, E. P. (1986). The role of extracurricular activities in education. *The High School Journal*, *69*(2), pp. 110-119. Retrieved from http://www.jstor.org.proxy.mul.missouri.edu/stable/40365131

Heller, M. F. & Firestone, W. A. (1995). Who's in charge here? Sources of leadership for change in eight schools. *The Elementary School Journal, 96*(1), 65-86.

Hermes, L. (1999). Learner assessment through subjective theories and action research. *Assessment and Evaluation in Higher Education, 24 (2*): 197-204.

Hernez-Broome, G., Hughes, R. L., & Center for Creative Leadership. (2009). Leadership development: Past, present, and future. *Human Resource Planning,* pp. 24-32. Retrieved from http://www.ccl.org/leadership/pdf/research/cclLeadershipDevelopment.pdf

Hersey, P. & Blanchard, K. H. (1982). Leadership style: Attitudes and behaviors. *Training and Development Journal, 36*(5), 50-52.

Hoyt, C. L. & Johnson, S. K. (2011). Gender and leadership development: A case of female leaders. In S. E. Murphy and R. J. Reichard (Eds.). *Early development and leadership: Building the next generation of leaders*. New York: Psychology Press/Routledge.

Inhelder, B., & Piaget, J. (2013). *The growth of logical thinking from childhood to adolescence: An essay on the construction of formal operational structures*. London: Routledge.

Karnes, F. A. & Bean, S. E. (1995). *Leadership for students: A practical guide for Ages 8 – 18*. Waco, TX: Prufrock Press.

Klassen, R. M., & Krawchuk, L. L. (2009). Collective motivation beliefs of early adolescents working in small groups. *Journal of School Psychology, 47*(2), 101-120. doi:10.1016/j.jsp.2008.11.002

Kouzes, J. M. & Posner, B. Z. (2001). *Leadership practices inventory – participant's workbook* (2nd ed.). Retrieved August 12, 2011, from http://consummatecoaching.com/images/LPI-WB_book.pdf

Kouzes, J. M. & Posner, B. Z. (2003). *The leadership practices inventory* (3rd ed.). Pfeiffer, John Wiley and Sons.

Kouzes, J. M. & Posner, B. Z. (2008). *The leadership challenge* (4th ed.). San Francisco, CA: Jossey-Bass.

Kress, C. A. (2006). Youth leadership and youth development: Connections and questions. *New Directions for Youth Development, 109*, 45-56.

Kudo, F. T., Longhofer, J. L., & Floersch, J. E. (2012). On the origins of early leadership: The role of authoritative parenting practices and mastery orientation. *Leadership, 8*(4), 345-375. doi:10.1177/1742715012439431

Lewin, K., Lippitt, R., & White, R.K. (1939). Patterns of aggressive behavior in experimentally created social climates. *Journal of Social Psychology, 10*, 271–301.

Libby, M., Sedonaen, M. & Bliss, S. (2006). The mystery of youth leadership development: the path to just communities. *New Directions for Youth Development, 109*, 13-25.

Linden, R. C., Wayne, S. J., Zhao, H., & Henderson, D. (2008). Servant leadership: Development of a multidimensional measure and multi-level assessment. *The Leadership Quarterly, 19*, 161-177.

Lizzio, A., Dempster, N., & Neumann, R. (2011). Pathways to formal and informal student leadership: the influence of peer and teacher–student relationships and

level of school identification on students' motivations. *International Journal of Leadership in Education, 14*(1), 85-102.

Lord, R.G., DeVader, C.L., & Alliger, G.M. (1986). A meta-analysis of the relation between personality traits and leadership perceptions: An application of validity generalization procedures. *Journal of Applied Psychology, 71*, 402-410.

MacNeil, C. A. (2006). Bridging generations: Applying "adult" leadership theories to youth leadership development. *New Directions for Youth Development, 109*, 27-43.

Mann, R. D. (1959). A review of the relationship between personality and performance in small groups. *Psychological Bulletin, 66(4),* 241-70.

Maxcy, B. D. & Nguyen, T. S. T. (2006). The politics of distributing leadership: reconsidering leadership distribution in two Texas elementary schools. *Educational Policy, 20*(1), 163-196.

McGregor, D.M. (2005). The human side of enterprise. In J. M. Shafritz, J. S. Ott, & Y. S. Jang (Eds.), *Classics of organization theory,* 6th ed. (pp. 179-184). Belmont, CA: Thomson Wadsworth. (Reprinted from Management Review, by D.M. McGregor, 1957, New York, NY: American Management Association)

McGregor, D. & Cutcher-Gershenfeld, J. (2006). *The human side of enterprise* [Google Books version]. Retrieved from http://books.google.com/books?id=0Td-U8yTjVEC&printsec=frontcover&source=gbs_atb#v=onepage&q&f=false

McNae, R. (2010). Young women and the co-construction of leadership. *Journal of Educational Administration, 48*(6), 677-688.

Mertens, D.M. (2005). *Research methods in education and psychology: Integrating diversity with quantitative and qualitative approaches* (2nd ed.). Thousand Oaks: Sage.

Miner, J. B. (2005). *Organizational Behavior: Behavior 1: Essential Theories of Motivation and Leadership*. Armonk: M.E. Sharpe.

Mitra, D.L. (2005). Adults advising youth: Leading while getting out of the way. *Educational Administration Quarterly, 41*(3), 520–553.

Murphy, S. E. (2011). Providing a foundation for leadership development. In S. E. Murphy and R. J. Reichard (Eds.). *Early development and leadership: Building the next generation of leaders*. New York: Psychology Press/Routledge.

Murphy, S. E. & Johnson, S. K. (2011). The benefits of a long-lens approach to leader development: Understanding the seeds of leadership. *The Leadership Quarterly, 22*, 459-470.

Murphy, S. E. & Reichard, R. J. (2011). Early development and leadership*: Building the next generation of leaders*. New York: Psychology Press/Routledge.

Nirenberg, J. (2004). Leadership effectiveness. In G. Goethals, G. Sorenson, & J. Burns (Eds.), *Encyclopedia of leadership*. (pp. 840-844). Thousand Oaks, CA: SAGE Publications, Inc.

Peterson, A. (1988). Adolescent development. *Annual Review of Psychology, 39*, 583-607.

Phipps, K.A. (2010). Servant leadership and constructive development theory: How servant leaders make meaning of service. *Journal of Leadership Education, 9*, 151 – 170.

Posner, B. Z. (2004). A leadership development instrument for students: updated [Electronic version]. *Journal of College Student Development, 45*, 4.

Posner, B.Z. & Brodsky, B. (1994). Leadership practices of effective student leaders: gender makes no difference. *NASPA Journal, 31*(2), 113-120.

Powless, M. D., Steinfeldt, J. A., & Beebe, K. E. (2017). The leadership academy: Evaluation of the effectiveness of an adolescent leadership development programme. *Graduate Journal of Sport, Exercise & Physical Education Research, 6*, 1-15.

Reccia, S. L. (2011). Preschool leaders in the early childhood classroom. In S. E. Murphy and R. J. Reichard (Eds.). *Early development and leadership: Building the next generation of leaders*. New York: Psychology Press/Routledge.

Redmond, S., & Dolan, P. (2016). Towards a conceptual model of youth leadership development. *Child & Family Social Work, 21*(3), 261-271. doi:10.1111/cfs.12146

Reichard, R. J., Riggio, R. E., Wright Guerin, D., Oliver, P. H., Gottfried, A. W., & Gottfried, A. E. (2011). A longitudinal analysis of relationships between adolescent personality and intelligence with adult leader emergence and transformational leadership. *The Leadership Quarterly, 22,* 471-481.

Rhodes, J. & Lowe, S. R. (2008). Youth mentoring and resilience: Implications for practice. *Child Care in Practice, 14*(1), 9-17.

Ricketts, J. C. & Rudd, R. D. (2004). Leadership development factors leading to the success of former Florida state FFA officers. *Journal of Southern Agricultural Education Research, 54*(1), 242-253.

Roberts, D. & Ullom, C. (1989). Student leadership program model. *NASPA Journal, 27*, 67-74.

Russell, R. F. & Stone, A. G. (2002). A review of servant leadership attributes: Developing a practical model. *Leadership and Organization Development Journal, 23*, 145-157.

Saldaña, J. (2013). *The Coding Manual for Qualitative Researchers*. Los Angeles, CA: SAGE Publications, Inc.

Saunders, R. (2005). Youth leadership: creating meaningful leadership programmes for young women through a process of co-construction. *New Zealand Journal of Educational Leadership, 20*, 15-30.

Schneider, B., Paul, M. C., White, S. S., & Holcombe, K. M. (1999). Understanding high school student leaders, I: Predicting teacher ratings of leader behavior. *Leadership Quarterly*, *10*(4), 609–636.

Scribner, J. P. & Donaldson, J. F. (2001). The dynamics of group learning in a cohort: from nonlearning to transformative learning. *Educational Administration Quarterly, 37*(5), 605-636.

Spillane, J. P. (2005). *Distributed Leadership*. San Francisco, CA, Jossey-Bass.

Spillane, J. P., Halverson, R., & Diamond, J. B. (2001). Investigating school leadership practice: a distributed perspective. *Educational Researcher, 30(3)*, 23-28.

Spillane, J. P., Halverson, R., & Diamond, J. B. (2004). Towards a theory of leadership practice: a distributed perspective. *Journal of Curriculum Studies, 36(1)*, 3-34.

Starrat, R. J. (2001). Democratic leadership theory in late modernity: an oxymoron or ironic possibility? *International Journal of Leadership in Education, 4*(4), 333-352.

Starratt, R.J. (2007). Leading a community of learners. *Educational Management Administration & Leadership, 35*(2): 165–83.

Sternberg, L. & Morris, A. (2001). Adolescent development. *Journal of Cognitive Education and Psychology, 1*(1), 55-87.

Stogdill, R. M. (1948). Personal factors associated with leadership: a survey of the literature. *Journal of Psychology, 25*, 35-71.

Stogdill, R.M. (1974). *Handbook of leadership: A survey of the literature*. New York: Free Press.

Striffolino, P. & Saunders, S.A. (1989). Emerging leaders: Students in need of development. *NASPA Journal, 27*, 51-58.

van Linden, J. & Fertman, C. I. (1998). *Youth leadership: A guide to understanding leadership development in adolescents*. San Francisco: Jossey-Bass.

Vygotsky, L.S. (1978). *Mind and society: The development of higher psychological processes*. Cambridge, MA: Harvard University Press.

Whitehead, G. (2009). Adolescent leadership development: Building a case for an authenticity. *Educational Management Administration Leadership*, 37, 847-872.

Yukl, G. (2010). *Leadership in Organizations* (7th ed.). Upper Saddle River, NJ: Pearson Education.

Yukl, G. (2012). Effective leadership behavior: What we know and what questions need more attention. *Academy of Management Perspectives, 26*(4), 66-85. doi:10.5465/amp.2012.0088

Appendix A

Initial Invitation to Participate

Please consider participating in a research project titled, Adolescent Leadership Development through Participation in a Robotics Challenge Experience. The dissertation research project will be conducted by University of Missouri-Columbia doctoral-student researcher, David Doering, and supervised by Dr. Paul Watkins.

What will the team do for this research project?

- Schedule at least three practices/meetings
- Invite David to observe at least three practices/meetings

What will the youth do for this research project?

- Participate in practices/meetings and the April challenge event as you already plan to do

Participate in a focus group a few days after the challenge event

What will the adult-mentors do for this project?

- Participate in practices/meetings and the April challenge event as you already plan to do
- Participate in a focus group a few days after the challenge event

What will David do?

- Observe at least three practices/meetings
- Observe the April challenge event

Facilitate a focus group for the youth and one for the adults

For more information

Visit http://goo.gl/OdNbtT

My team is possibly interested, here is my contact information –

Complete the form at http://goo.gl/0n7yrK

Appendix B

Invitation to Participate and Informed Consent Form – Youth (9 to 11)

Dear Participant,

You are invited to be a part of a research project titled Adolescent Leadership Development through Participation in a Robotics Challenge Experience.

Purpose

The researcher will watch your team meetings and make note of what youth and adults do when leadership development opportunities occur.

Level of Participation of Youth

- Your participation in this research project is voluntary and optional.
- You will attend meetings for three months as scheduled by your team.

Three of the meetings will be observed.

- You will participate in one focus group after your team's local challenge event date.
- You are free to not answer individual focus group questions.
- You may experience nervousness or potential for embarrassment.

Timeline (Contact with Researcher)

- January Please sign and return this form
- January First Observation of Team Meeting (60 to 90 minutes)
- February Second Observation of Team Meeting (60 to 90 minutes)
- March Third Observation of Team Meeting (60 to 90 minutes)
- As Needed Additional Observations of Team (60 to 90 minutes)
- After Challenge EventPost-Local-Challenge Focus Group (60 to 90 minutes)

Video Recording

- The three team meeting observations and your focus group will be passively video-recorded. All video will be confidential.

Risks

- Focus group members will be asked to keep information provided in the groups confidential; however, a potential risk for some is that information might be discussed outside the group by others and be traced back to you.

Sign-up!

Detach, complete this form, and return it to the researcher.

If you want to participate in this research project, please sign and return this informed consent form to David Doering.

Thank you for your time!

Sincerely,

David Doering

Doctoral Student

Educational Leadership and Policy Analysis

University of Missouri-Columbia

If not returned in person, mail this page in the provided stamped envelope to David Doering, 3137 Harper's Ferry Drive, O'Fallon, MO 63368 before the first team observation.

Please complete the information below:

First Name Middle Initial Last Name

Birth Date Grade Level Team Name or Description

1st 2nd 3rd 4th 5+ Male Female

Years in robotics (Circle One) Gender (Circle One)

Please SIGN below:

Yes, I give consent to participate in this research project.

Youth Signature Date

Thank you! Your parent will complete a form of his/her own.

Appendix C

Invitation to Participate and Informed Consent Form – Youth (12 to 14)

Dear Participant,

You are invited to be a part of a research project titled Adolescent Leadership Development through Participation in a Robotics Challenge Experience. The project will look at experiences of members of MU Robotics Challenge teams.

The research project will be conducted by University of Missouri-Columbia doctoral student researcher, David Doering (dadkb4@mail.missouri.edu), and supervised by Dr. Paul Watkins (pwatkins@semo.edu).

Purpose

You may view some of your friends and classmates as leaders. Many people believe that leadership skills, behaviors, and attitudes can be developed in a person. MU Robotics Challenge does NOT claim to be a leadership development program, but it includes mentoring, challenging problems, goal setting, teamwork, and experiential learning which have been identified as having potential for leadership development in adults. The researcher will watch your team meetings and make note of what youth and adults do when there are leadership opportunities.

Level of Participation of Youth

- Your participation in this research project is voluntary and optional.
- You will attend meetings for three months as regularly scheduled by your team. Three of the meetings will be observed.
- You will participate in one focus group after your team's local competition date.
- You are free to not answer individual focus group questions.
- You may unintentionally experience nervousness or potential for embarrassment.

Timeline (Contact with Researcher)

- January Please sign and return this form
- January First Observation of Team Meeting (60 to 90 minutes)
- February Second Observation of Team Meeting (60 to 90 minutes)
- March Third Observation of Team Meeting (60 to 90 minutes)
- As Needed Additional Observations of Team (60 to 90 minutes)
- After Challenge EventPost-Local-Challenge Focus Group (60 to 90 minutes)

Video Recording

- The three team meeting observations and focus groups will be passively video-recorded. A video camera will record participant interactions using a wide-angle setting. All video data will be confidential.

Risks

- Youth may be nervous talking about the Robotics Design Challenge in a group setting. Focus group members will be asked to keep information provided in the groups confidential; however, a potential risk that may exist for some would be that information might be discussed outside the group and be traced back to you.

Sign-up!

Detach, complete this form, and return it to the researcher.

If you want to participate in this research project, please sign and return this informed consent form to David Doering. Thank you for your time!

Sincerely,

David Doering

Doctoral Student

Educational Leadership and Policy Analysis

University of Missouri-Columbia

If not returned in person, mail this page in the provided stamped envelope to David Doering, 3137 Harper's Ferry Drive, O'Fallon, MO 63368 before the first team observation.

Please complete the information below:

First Name Middle Initial Last Name

Birth Date Grade Level Team Name or Description

1st 2nd 3rd 4th 5+ Male Female

Years in robotics (Circle One) Gender (Circle One)

Please SIGN below:

Yes, I give consent to participate in this research project.

Youth Signature Date

Thank you! Your parent will complete a form of his/her own.

Appendix D

Invitation to Participate and Informed Consent Form – Adult Mentors

December 1, 2014

Dear Adult/Mentor Participant,

Thank you for taking the time to view this document. Please consider volunteering to participate in a research project titled, Adolescent Leadership Development through Participation in a Robotics Challenge Experience. The purpose of this document is to ask if you are willing to participate in this project examining possible adolescent leadership development experiences of participants of the Robotics Design Challenge sponsored by the University of Missouri Engineering Department.

The dissertation research project will be conducted by University of Missouri-Columbia doctoral student researcher, David Doering, and supervised by Dr. Paul Watkins, dissertation committee chairperson and Southeast Missouri State University Educational Leadership faculty member.

Research Purpose

Despite the existence of some well-known programs to develop youth leadership, there is little significant research devoted to leadership development during adolescence. The MU

Robotics Design Challenge does NOT claim to be a leadership development program, but it includes mentoring, challenging problems, goal setting, teamwork, and experiential learning which have been identified by researchers as having potential for leadership development in adults. This research will observe the implementation of five Robotics Design Challenge teams (approximately 15 youth and 10 adults). Data from the five teams will be compared to one another and existing adolescent and leadership research.

Level of Participation of Youth and Adult-mentors

- Attend meetings for three months as regularly scheduled by your team
- Actively participate in one Focus Group after your team's challenge event date

Approximate Timeline (Interaction with Researcher)

- January Please return signed Informed Consent Form
- January First Observation of Team Meeting (60 to 90 minutes)
- February Second Observation of Team Meeting (60 to 90 minutes)
- March Third Observation of Team Meeting (60 to 90 minutes)
- As Needed Additional Observations of Team (60 to 90 minutes)
- After Challenge EventPost-Local-Challenge Focus Group (60 to 90 minutes)

Project Description and Data Collection

This qualitative research project will investigate leadership development by collecting four types of data: (a) team meeting observations, (b) a youth focus group, (c) an adult-mentor focus group, and (d) document analysis.

- Team Meeting Observations. During at least three team-meeting observations, youth and adult mentors will perform in a typical manner as if the researcher is not present.

- Youth Focus Group. The focus group will involve all participating youth after the challenge event and will involve the researcher asking questions about leadership development to the group.

- Adult-Mentor Focus Group. The focus group will involve adults who assisted throughout the team meetings occurring after the challenge event and will involve the researcher asking questions about leadership development to all the participants.

- Document Analysis. Documents and written communications within the team will also be collected and analyzed.

Video Recording

All team meeting observations and focus groups will be passively video-recorded. A video camera will record participant interactions in the appropriate rooms utilizing a wide-angle setting. All video data will be considered strictly confidential and only viewed by the researcher and members of the dissertation committee. When not actively being analyzed, video will be stored in a combination-lock limited-access fire-safe for seven years in accordance with University of Missouri guidelines. Any additional use of video data will be prohibited unless approval has specifically been received by the participants in the video.

Potential Benefits

Upon completion of the research report, an abridged version will be shared with the participants. Reading the report and other sources of information about leadership and leadership development may lead to increased self-awareness and understanding of leadership. Participation is completely voluntary.

Potential Risks

Concerns are minimal as any risk is incidental. The researcher will be observing normal team activities and then asking a few questions about leadership development

during a focus group at the conclusion of the team. Observations and the focus-group may unintentionally raise an individual's anxiety level or potential for embarrassment.

Focus group members will be asked to keep information provided in the groups confidential; however, a potential risk that may exist for some would be that information about the Robotics Design Challenge might be discussed outside the group by other participants and be traced back to other participants.

Confidentiality

- Personal and demographic data are private. The following data will be collected on the Invitation to Participate and Informed Consent Form: name, birth date, grade level, experience with robots, gender, parent/guardian/adult e-mail address, and parent/guardian/adult phone number. Name, birth date, e-mail address, and phone number will NOT be transferred to any other form of documentation. Personal and demographic data will be stored in a key-lock limited-access fire-safe for seven years in accordance to University of Missouri guidelines (different safe than the data collection safe).
- All additional data will be connected to pseudonyms. Direct identifiers will not appear in any observation forms, note-taking sheets, data analysis documents, or reports.
- Data in this research project is confidential. Pseudonyms will be used during data collection. Raw data will only be viewed by the researcher; Dr. Paul Watkins, dissertation committee chairperson; and members of the dissertation committee. When not actively being analyzed, data will be stored in a combination-lock limited-access fire-safe for

seven years in accordance to University of Missouri guidelines (different safe than the personal information safe).

- Computer files created for the purpose of data collection will be stored on a computer only used by the researcher using a password-protected-user account that is only used for this research project.
- Resulting dissertation and additional papers will protect confidentiality by utilizing pseudonyms for the participants, the teams, and the region. When possible, aggregate data will be utilized versus individual responses. Individual statements (data) are very important to this study and may be included in subsequent reports. Individual statements may be attributed to individual participants in the following manners: "youth from team B", "a participant", or using a Pseudonym – "Jane said".

Participation is Voluntary

- Participation in this research project is entirely voluntary and optional.
- Individuals choosing to not participate will experience no penalty.
- Participants may withdraw at any time without consequences. Data provided by withdrawn participants will be removed from the project upon request. Youth quitting the team will be considered withdrawn.
- Participants are free to choose to not respond to individual focus group questions.
- In agreeing to participate, the youth should understand that they should proceed as normal during team meetings and that at the conclusion of the challenge event they will

participate in a focus group with their youth team members to discuss leadership development.

Results of the Study

- An abridged report will be made available to the participants upon completion – approximately six months after the focus group.
- Results of this research project will be used to fulfill the dissertation requirement of the researcher participating in a Doctor of Education program at the University of Missouri.
- Results of this research may be shared with schools and at state, regional, national, and international conferences.
- Results of this research may be published in scholarly journals or other education-related publications.

Questions

For more details regarding this research, methodology, or risks, please contact doctoral student researcher, David Doering, at dadkb4@mail.missouri.edu or call at 314 249 9326, or his faculty advisor (dissertation committee chairperson) Paul Watkins at pwatkins@semo.edu or at MS 5600, Department of Educational Leadership, Southeast Missouri State University, One University Plaza, Cape Girardeau, MO 63701.

If you have questions or concerns regarding your rights as a participant in this research contact the MU Campus Institutional Review Board at 483 McReynolds Hall, Columbia, MO 65211, 573 882 9585, umcresearchirb@missouri.edu.

Sign-up!

If you are willing to participate in this research project, please sign and return the enclosed informed consent form to David Doering in person or at the address on the consent form by the beginning of the first team observation. If you choose to not participate, please notify David Doering immediately in person or by e-mail at dadkb4@mail.missouri.edu.

Thank you for your time and consideration!

Sincerely,

David Doering

Doctoral Student

Educational Leadership and Policy Analysis

University of Missouri-Columbia

Detach, complete this form, and return it to the researcher.

If not returned in person, mail this packet in the provided stamped envelope to David Doering, 3137 Harper's Ferry Drive, O'Fallon, MO 63368 prior to the first team observation.

Please complete the information below:

_____

First Name Middle Initial Last Name

_____

Team Name or Description

1st 2nd 3rd 4th 5+ Male Female

Years with Robots (Circle One) Gender (Circle One)

Please SIGN below:

Yes, I give consent to participate in this research project examining adolescent leadership development.

_____

Signature Date

_____

E-mail Address (print clearly)

_____

Phone Number

Thank you!

Appendix E

Invitation to Participate and Informed Consent Form – Parents

December 1, 2014

Dear Parent/Guardian(s),

Thank you for taking the time to view this document. Please consider consenting for your child to participate in a research project titled, Adolescent Leadership Development through Participation in a Robotics Challenge Experience. The research project will examine possible adolescent leadership development experiences of participants of the Robotics Design Challenge sponsored by the University of Missouri Engineering Department.

The dissertation research project will be conducted by University of Missouri-Columbia doctoral student researcher, David Doering, and supervised by Dr. Paul Watkins, dissertation committee chairperson and Southeast Missouri State University Educational Leadership faculty member.

Research Purpose

Despite the existence of some well-known programs to develop youth leadership, there is little significant research devoted to leadership development during adolescence. The MU

Robotics Design Challenge does NOT claim to be a leadership development program, but it includes mentoring, challenging problems, goal setting, teamwork, and experiential learning which have been identified by researchers as having potential for leadership development in adults. This research will observe the implementation of five Robotics Design Challenge teams (approximately 15 youth and 10 adults). Data from the five teams will be compared to one another and existing adolescent and leadership research.

Level of Participation of Youth and Adult-mentors

- Attend meetings for three months as regularly scheduled by your team
- Actively participate in one Focus Group after your team's challenge event date

Approximate Timeline (Interaction with Researcher)

- January Please return signed Informed Consent Form
- January First Observation of Team Meeting (60 to 90 minutes)
- February Second Observation of Team Meeting (60 to 90 minutes)
- March Third Observation of Team Meeting (60 to 90 minutes)
- As Needed Additional Observations of Team (60 to 90 minutes)
- After Challenge EventPost-Local-Challenge Focus Group (60 to 90 minutes)

Project Description and Data Collection

This qualitative research project will investigate leadership development by collecting four types of data: (a) team meeting observations, (b) a youth focus group, (c) an adult-mentor focus group, and (d) document analysis.

- Team Meeting Observations. During at least three team-meeting observations, youth and adult mentors will perform in a typical manner as if the researcher is not present.

- Youth Focus Group. The focus group will involve all participating youth after the local competition and will involve the researcher asking questions about leadership development to the group.

- Adult-Mentor Focus Group. The focus group will involve adults who assisted throughout the team meetings occurring after the local competition and will involve the researcher asking questions about leadership development to all the participants.

- Document Analysis. Documents and written communications within the team will also be collected and analyzed.

Video Recording

All team meeting observations and focus groups will be passively video-recorded. A video camera will record participant interactions in the appropriate rooms utilizing a wide-angle setting. All video data will be considered strictly confidential and only viewed by the researcher and members of the dissertation committee. When not actively being analyzed, video will be stored in a combination-lock limited-access fire-safe for seven years in accordance with University of Missouri guidelines. Any additional use of video data will be prohibited unless approval has specifically been received by the participants in the video.

Potential Benefits

Upon completion of the research report, an abridged version will be shared with the participants. Reading the report and other sources of information about leadership and leadership development may lead to increased self-awareness and understanding of leadership. Participation is completely voluntary.

Potential Risks

Concerns are minimal as any risk is incidental. The researcher will be observing normal team activities and then asking a few questions about leadership development

during a focus group at the conclusion of the team. Observations and the focus-group may unintentionally raise an individual's anxiety level or potential for embarrassment.

Focus group members will be asked to keep information provided in the groups confidential; however, a potential risk that may exist for some would be that information about the Robotics Design Challenge might be discussed outside the group by other participants and be traced back to the youth or adults.

Confidentiality

- Personal and demographic data are private. The following data will be collected on the Invitation to Participate and Informed Consent Form: name, birth date, grade level, experience with robots, gender, parent/guardian/adult e-mail address, and parent/guardian/adult phone number. Name, birth date, e-mail address, and phone number will NOT be transferred to any other form of documentation. Personal and demographic data will be stored in a key-lock limited-access fire-safe for seven years in accordance to University of Missouri guidelines (different safe than the data collection safe).
- All additional data will be connected to pseudonyms. Direct identifiers will not appear in any observation forms, note-taking sheets, data analysis documents, or reports.
- Data in this research project is confidential. Pseudonyms will be used during data collection. Raw data will only be viewed by the researcher; Dr. Paul Watkins, dissertation committee chairperson; and members of the dissertation committee. When not actively being analyzed, data will be stored in a combination-lock limited-access fire-safe for

seven years in accordance to University of Missouri guidelines (different safe than the personal information safe).

- Computer files created for the purpose of data collection will be stored on a computer only used by the researcher using a password-protected-user account that is only used for this research project.
- Resulting dissertation and additional papers will protect confidentiality by utilizing pseudonyms for the participants, the teams, and the region. When possible, aggregate data will be utilized versus individual responses. Individual statements (data) are very important to this study and may be included in subsequent reports. Individual statements may be attributed to individual participants in the following manners: "youth from team B", "a participant", or using a Pseudonym – "Jane said".

Participation is Voluntary

- Participation in this research project is entirely voluntary and optional.
- Individuals choosing to not participate will experience no penalty.
- Participants may withdraw at any time without consequences. Data provided by withdrawn participants will be removed from the project upon request. Youth quitting the team will be considered withdrawn.
- Participants are free to choose to not respond to individual focus group questions.
- In agreeing to participate, the youth should understand that they should proceed as normal during team meetings and that at the conclusion of their local competition they

will participate in a focus group with their youth team members to discuss leadership development.

Results of the Study

- An abridged report will be made available to the participants upon completion – approximately six months after the focus group.
- Results of this research project will be used to fulfill the dissertation requirement of the researcher participating in a Doctor of Education program at the University of Missouri.
- Results of this research may be shared with schools and at state, regional, national, and international conferences.
- Results of this research may be published in scholarly journals or other education-related publications.

Questions

For more details regarding this research, methodology, or risks, please contact doctoral student researcher, David Doering, at dadkb4@mail.missouri.edu or call at 314 249 9326, or his faculty advisor (dissertation committee chairperson) Paul Watkins at pwatkins@semo.edu or at MS 5600, Department of Educational Leadership, Southeast Missouri State University, One University Plaza, Cape Girardeau, MO 63701.

If you have questions or concerns regarding your rights as a participant in this research contact the MU Campus Institutional Review Board at 483 McReynolds Hall, Columbia, MO 65211, 573 882 9585, umcresearchirb@missouri.edu.

Sign-up!

If you are willing to allow your child to participate in this research project, please sign and return the enclosed informed consent form to David Doering in person or at the address on the signature page by the beginning of the first team observation. If you choose to not allow your child to participate, please notify David Doering immediately in person or by e-mail at dadkb4@mail.missouri.edu.

Thank you for your time and consideration!

Sincerely,

David Doering

Doctoral Student

Educational Leadership and Policy Analysis

University of Missouri-Columbia

Detach, complete this form, and return it to the researcher.

If not returned in person, mail this packet in the provided stamped envelope to David Doering, 3137 Harper's Ferry Drive, O'Fallon, MO 63368 prior to the first team observation.

Please complete the information below:

_____

Parent's Printed First Name Middle Initial Parent's Printed Last Name

Please SIGN below:

Yes, I give consent for my child to participate in this research project which will examine adolescent leadership development.

_____

Print Child's Name Date

_____

Parent/Guardian's Signature

_____

Parent/Guardian's E-mail Address (print clearly)

_____

Parent/Guardian's Phone Number

Thank you!

Appendix F

Meeting Observation Protocol

Team Name (Alias)	Date
Location First Second Third Fourth Fifth	Start Time End Time Minutes
Which observation?	Video Label

Adult/ Youth	Pseudonym	Clothing Description	Sketch of Environment
A Y			
A Y			
A Y			
A Y			
A Y			
A Y			
A Y			
A Y			

Additional Information

Approximate Time	**Descriptive Notes**	**Reflective Notes**

Approximate Time	**Descriptive Notes**	**Reflective Notes**

Appendix G

Adolescent Focus Group Possible Questions

Introductory Statement

Thank you for allowing me to observe several of your team meetings this winter. Today is the last day that you will participate in this research study. The purpose of the study is to examine adolescent leadership development. For the next hour or so I will ask some questions and you will answer the questions as individuals and as a group. This is NOT an opportunity to complain about a team member or remind others of disagreements. Your responses should be honest, but as positive as possible. Any questions?

Questions

1. Your pseudonym/alias is?

How old are you?

How many years have you been working with LEGO robots?

Introduce Planned Procedure

- Prompt - 20s – verbally and in writing
- Reflection – 20s – reflect on question for 20 seconds – no writing just thinking
- Writing – 40s – write down thoughts, phrases, or keywords
- Sharing – 120s – one at a time participants state their response to the prompt
- Discussion – up to 120s – after sharing participants are allowed to discuss and build upon one another's responses

2. Practice Procedure – What is your favorite color

AND 3 reasons why?

Your pseudonym/alias is?

3. Describe your favorite part of being on a robotics team?

4. What does it mean to be a leader?

5. Are you a leader?

How do you know you are a leader?

Give an example of when you were a leader during the MU Robotics Design Challenge.

6. What does it mean to develop leadership?

7. For the next few items please reflect on the concept I state related to

MU Robotics Design Challenge and leadership development

and answer what is your opinion about the concept and can you think of an example that explains your thoughts on the concept:

a. Goal setting

b. Teamwork

c. Feedback from peers and adult mentors

d. Experiential learning

e. Challenging problem

f. Variety of tasks

8. What about your experience with MU Robotics Design Challenge helped develop you as a leader?

We are almost finished, two more questions.

9. One of the research questions of this study is "how do adolescent participants describe leadership development experiences in the MU Robotics Design Challenge?" Thinking about leadership development of yourself and your team members is there anything else you can say that might help me better understand leadership development?

10. Do you have any questions or comments?

Conclusion

Thank you very much! This concludes your participation in the research study.

Appendix H

Adult-Mentor Focus Group Possible Questions

Introductory Statement

Thank you for allowing me to observe several of your team meetings this winter. Today is the last day that you will participate in this research study. The purpose of the study is to examine adolescent leadership development. For the next hour or so I will ask some questions and you will answer the questions as individuals and as a group. This is NOT an opportunity to complain about the youth, another adult, the MU Robotics Design Challenge, or remind others of disagreements. Your responses should be honest, but as positive as possible. Any questions?

Questions

1. Your pseudonym/alias is?

Describe your level of experience with robots, programming, leadership, and/or mentoring -

Introduce Planned Procedure

- Prompt - 20s – verbally and in writing
- Reflection – 20s – reflect on question for 20 seconds – no writing just thinking
- Writing – 40s – write down thoughts, phrases, or keywords
- Sharing – 120s – one at a time participants state their response to the prompt
- Discussion – up to 120s – after sharing participants are allowed to discuss and build upon one another's responses

2. Practice Procedure – What is your favorite color

AND 3 reasons why?

Your pseudonym/alias is?

3. What does it mean to be a leader?

4. What does it mean to develop leadership?

5. Please identify some examples in which the MU Robotics Design Challenge may have helped develop leadership in one or more of the youth.

6. For the next few items please reflect on the concept I state related to

MU Robotics Design Challenge and leadership development.

What role do you believe the concept has in developing leadership in the youth?

a. Goal setting

b. Teamwork

c. Feedback from peers and adult mentors

d. Experiential learning

e. Challenging problem

f. Variety of tasks

7. What about the experience with MU Robotics Design Challenge helped develop the youth as a leader?

We are almost finished, two more questions.

8. One of the research questions of this study is "how do adult-mentor participants describe leadership development experiences in the MU Robotics Design Challenge?" Thinking about leadership development of the youth is there anything else you can say that might help me better understand leadership development?

9. Do you have any questions or comments?

Conclusion

Thank you very much! This concludes your participation in the research study.

Appendix I

Potential Leadership Traits Behaviors and Concepts to Observe

Bass and Bass (2008) identified five categories of leadership trait competencies:

(a) cognitive -	intelligence	knowledge	vision
(b) social competency -	assertiveness	attractiveness	empathy
(c) emotional competency -	self-confidence	self-esteem	self-efficacy
(d) biophysical -	stature	physical fitness	
(e) character -	integrity	honesty	discipline

Kouzes and Posner (2001, 2008) acknowledge the traits above and categorize related behaviors into five themes:

(a) Modeling the Way - setting high standards and living up to those standards daily

(b) Inspiring a Shared Vision - vision for the future and ability to encourage others to act on that vision

(c) Challenging the Process - taking risks to change the status quo and find innovative ways to improve

(d) Enabling Others to Act - strengthen others making each person feel capable and powerful leading to teamwork and team decision-making

(e) Encouraging the Heart - encouragement and recognition.

Leadership Development Concepts

amount of challenge	variety of tasks	quality and acceptance of feedback
developmental readiness	self-regulatory focus	motivation to lead
learning goal orientation	self-efficacy	self-awareness
self-discovery	reflection	

Theories and Concepts

Constructivism	Democratic Leadership	Servant Leadership
Situational Leadership	Subjective Leadership	

Additional Concepts

extraversion	agreeableness	charisma	flexible
creativity	need for power	oral skills	written skills
social skills	problem solving	decision making	technical knowledge
people management	task management	focus	passion
respect	clarity	compassion	supportive
role model	optimistic	strategy	priorities
motivating	delegating	listening	communicating
coaching	influential	gracious	

Redmond and Dolan (2014)

Social and Emotional Intelligence -	self-awareness	relate to others	confidence
Collaborate -	team build		problem solving
	conflict resolution		decision making
Articulate -	communicate		oral/written
Insight and Knowledge -	critical thinking	evidence/facts	ethics
Authentic Opportunity -	participation		giving
Mentor Access -	guidance		structure
	receiving (must be willing to be guided)		
Mastering -	persist		reflect
Motivating -	role model		purpose

VITA

David Doering completed his Doctor of Education in Educational Leadership and Policy Analysis from the University of Missouri – Columbia in December, 2018. He also earned a Master of Education in Information Science and Learning Technologies with an emphasis in Educational Technology from the University of Missouri – Columbia in August, 2014, and a Bachelor of Science in Education with an emphasis in Business Education from the University of Missouri – Columbia in May, 1993.

David Doering is currently employed as an Associate Professor of Information Systems at St. Louis Community College in St. Louis, Missouri. He has served on numerous committees including instructional technology advisory group, academic governance, institutional governance, and curriculum. He has developed numerous courses for online delivery. Prior to working at the college, he served as an Education Technology Specialist and teacher of Business at Riverview Gardens School District, a teacher of Computer Technology at Valley Park High School, and a teacher of Science at Francis Howell High School.