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Experiential education: Understanding the impact of remotely operated vehicles on at-risk student learning

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Experiential Education: Understanding the Impact of Remotely Operated Vehicles on At-Risk Student Learning

by

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Dedication

This dissertation is dedicated to my entire family in deep gratitude for their love, support, and sacrifice. Thank you for extending such grace.

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The completion of this dissertation has been one of the most significant academic challenges I have undertaken. It is with heartfelt gratitude that I acknowledge several individuals for their help and encouragement; without their support, patience, and guidance, I may not have completed this study.

As a first generation college graduate, I deeply appreciate the encouragement and support of my immediate and extended family. Lifelong learning has been modeled for me in many different ways. I offer deep and sincere gratitude to my wife, Susan, who not only encouraged me, but also picked up a tremendous amount of domestic slack. My children, Trinity and Carter, who forgave much, put up with much, and loved much. I know the water park trips did not fully make up for missed time, but they were fun.

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Abstract

How do educators engage students in the curriculum? State and Common Core Standards determine what to teach; how those standards are taught varies. This research examined a group of at-risk elementary and secondary students using underwater Remotely Operated Vehicles (ROVs) as part of an experiential education program in a rural Michigan school district. With a foundation of grounded theory, qualitative methods are used in this case study of the experience of at-risk learners whose mission is to solve a problem. In particular, the story evolves from nine emergent themes identified in the experiences of students and adults: attendance, communication, confidence, engagement, fun, problem-solving, responsibility, teamwork, and time. Common across the nine themes is the conclusion that student motivation strongly impacts learning that is perceived to be hands-on and relevant.

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Chapter One: Introduction

Our nation, state, and local economies have dramatically changed in this new century. We were extremely successful under the industrial model; thus, many of our social systems were designed to reflect the same roles and responsibilities of a factory. Educational systems mirror the industrial model in everything from buildings, to personnel, to curriculum. Long and Holeton (2009) stated "The industrial model has a strict set of rules and regimented behavior, identical curricula and expectations for all students, and an emphasis on basic skills of literacy and numeracy" (p. 38).

The global economy can be felt in almost every part of our lives, and the industrial model is no longer working in our country. However, our education system still reflects the same industrial model as it did in the 1900s. In a March 1, 2010, speech to the U.S. Chamber of Commerce, President Obama stated, "Now it's true that not long ago you could drop out of high school and reasonably expect to find a blue-collar job that would pay the bills and help support your family, that's just not the case anymore."

The changes in our economy require the application of problem-solving and critical thinking skills for collective and individual success (Rotherham & Willingham, 2009). The job market continues to be hyper competitive, and a high school degree has become a primary filter for employment. For students without a high school degree, lifetime earnings are significantly less than for those with a degree (McDaniel & Kuehn, 2013). Therefore, it is imperative to help at-risk students stay in school and develop critical thinking and problem-solving skills.

Background

The term at-risk does not have a single definition when applied to students in K-12 education. One could argue that all students are some way or another at-risk, but we are discussing students that are at risk of exiting from K-12 education before successful completion. Simply stated, at-risk students are students who have the highest risk of failing at school (Levison & Sadovnik, 2002).

As educators, and as a society, we need to be concerned about at-risk learners. Generally speaking, failure at school leads to a much harder life. Students who drop out of school generally have difficulty obtaining gainful employment. They have a higher likelihood of being involved in anti-social behaviors, which often tax the support systems of a community (Natriello, 1986). Ruff (1993) stated that risk factors such as language and cultural barriers, dysfunctional family dynamics, and residing in economically disadvantaged communities predicted adverse educational outcomes.

Because many at-risk factors are out of a school's ability to control or fix, school officials may need to examine their established procedures to see if the procedures can be more helpful to at-risk students. Perhaps a change from the industrial model of education to a more involved, problem-solving, project-based, experiential education setting would help these students (Morehouse, 2008).

The Association of Experiential Education (AEE) stated, "Education is a process through which the learner constructs knowledge, skill, and value from direct education." Experiential education is a philosophy and methodology in which educators purposefully engage with learners in direct experience and focused reflection in order to increase knowledge, develop skills, and clarify values (Fox, 2008). In the briefest terms, some say that experiential education is simply learning by doing. Kraft and Sakofs (1988) provided the following definition of experiential education:

> Experiential education is the process of actively engaging students in an authentic experience that will have benefits and consequences. Students make discoveries and experiment with knowledge themselves instead of hearing or reading about the experiences of others. Students also reflect on their experiences, thus developing new skills, new attitudes, and new theories of ways of thinking. (p. 12)

Proudman (1995) proposed a set of principles that guide the experiential education process: a mixture of content and process, the lack of overriding teacher judgment, student engagement in purposeful activities, focus on the big picture perspective, multiple learning styles, cultivation of students' emotional investment, building meaningful relationships, learning outside of one's comfort zone, and reflection.

At-risk students are not identical, and therefore, do not all learn the same way. However, it appears if at-risk students feel a sense of engagement, they have a higher likelihood of experiencing success (Smerdon, 2002). Peabody (2011) compared at-risk students from four different high schools. Based on criteria in No Child Left Behind legislation (NCLB, 2001), two of the schools were considered to be high-preforming schools and two were considered to be low-performing schools. Student engagement was one of the largest distinctions between the high- and low-performing schools. In the low-performing schools, students were not engaged; they were passive recipients of knowledge. While in the classroom, the students' interest and attention were also low. In the high-performing schools, the at-risk students were included in the curriculum design and implementation process. The high-performing schools had high student engagement, and the focus was on the student. The low-performing schools were much more teacher-centered.

Some schools have exposed students to experiential education in the form of a Remotely Operated Vehicle (ROV), a tethered underwater vehicle or robot. ROVs are unoccupied, highly maneuverable, and operated by a person aboard a vessel or on shore. The tether consists of cables that carry electrical power and video and data signals back and forth between the operator and the vehicle. ROVs range in size and expense from a few kilograms in weight and fewer than one hundred dollars in cost to models equipped with 500 hp engines costing millions of dollars (Marine Advanced Technology Education Center, 2011).

One of the primary goals of public education is to help students transition into productive and career-oriented work lives. A growing body of research literature suggested that experiential education activities and experiences have the potential to be effective at achieving this goal (Baldwin, Persing, & Magnuson, 2004; Hattie, Marsh, Neill, & Richards, 1997). Experientially based programs that directly engage the student in the learning process seem to promote learning. The promotion of learning leads to an increase of skills that can be transferred to career lives.

Mukai and McGregor (2004) found that students responded better to higher-order assessments that were more challenging than they did to more basic knowledge assessments. Jonassen (2003) also stated that technology, when used as a learning tool, can assist in the development of meaning. This can then lead to increasing the likelihood of understanding and knowledge retention. Day (2002) immersed at-risk students in a learning environment located within a technology lab. He noticed cooperative learning, authentic tasks and assessments, and meaningful use of technology dramatically impacted the motivation and engagement of at-risk students.

Research Problem

Even though the nationwide dropout rate has decreased over the last 20 years (U.S. Department of Education, National Center for Education Statistics, 2013), at-risk students continue to have difficulties in school. Instruction of at-risk students has not changed dramatically during this period of time, and schools continue to struggle to meet the needs of at-risk students (Day, 2002). Hanushek, Lindseth, and Rebell (2009) added, “The underlying system has remained largely unchanged” (p. 40).

Although there are many examples of experiential education, much of the research takes place outside of the school system and classroom environment (Sibthorp, 2009). The research regarding remotely operated vehicles is minimal. Therefore, I feel there is a need to further examine the impact of the instructional use of ROVs on at-risk student learning.

Research Questions

This research study addressed the following questions: How does experiential education and, in particular, the application of remotely operated vehicles in the curriculum impact at-risk student learning? Furthermore, to what degree do at-risk students feel engaged when working with ROVs, and why? To what degree do ROVs help at-risk students feel needed and involved in school, and why?

Purpose and Significance

The purpose of this study was to gain a deeper understanding of experiential education in the form of remotely operated vehicles. This study provided an opportunity to examine and explain a unique learning opportunity for elementary and secondary students and for the adults involved in the project. Additionally this qualitative case study presented the words and actions of at-risk learners leading to a deeper understanding of the teaching/learning dynamics relating to the at-risk learner.

Key Terms and Concepts

The following terms and concepts were explored in greater detail throughout the dissertation.

- **Academic relevancy**: When students feel as if the academic material in their classes is meaningful to their lives.
- **Adventure education:** Direct, active, and engaging learning experiences that involve the whole person and have real consequences. Adventure includes uncertain outcome, risk, inescapable consequences, energetic action, and willing participation.
- **At-risk students:** Students who have the highest risk of failing in school.
- **Ego involvement**: Students who are ego-involved perform the task to boost their own ego, for the praise that completing the task might attract, or because completing the task confirms their own self-concept.
- **Experiential education:** A philosophy and methodology in which educators purposefully engage with learners in direct experience and focused reflection to increase knowledge, develop skills, and clarify values.
- **Extrinsic goal orientation:** Similar to ego, when students perceive themselves as engaging in a task because of grades, rewards, performance, evaluation by others, and competition.
- **Intrinsic goal orientation**: Centers on students engaged in activities based on traits such as curiosity, task challenge, and improving or perfecting of mastery.

- **The Marine Advanced Technology Education (MATE) Center:** Education and research center whose mission is to provide the marine technical workforce with appropriately educated workers and to use marine technology to create interest in and improve science, technology, engineering and mathematics (STEM) education.
- **Ranger class:** MATE competition class most appropriate for middle schools with robotics experience, high schools, colleges, and universities new to robotics. Springfield High School students participated in the Ranger class.
- **Remotely Operated Vehicle (ROV):** A tethered underwater vehicle or robot. ROVs are unoccupied, highly maneuverable, and operated by a person aboard a vessel or on shore.
- **Rover students:** Student positions created for Legacy ROV team as a failsafe. The two rover students would not be on a specific three-person team. Instead, they would support all eight teams as well as the two coaches. If one of the 24 students on a team quit or was removed from the club, the rover students would take their position. Additionally, the rovers were guaranteed to go to the Tawas Bay contest.
- **Scout class:** MATE competition class most appropriate for upper elementary schools with robotics experience, middle schools and high schools new to robotics. Scout teams participate in regional events only. Legacy elementary students participated in the Scout class.
- **STEM education:** Science, Technology, Engineering and Mathematics, an interdisciplinary and applied approach that is coupled with real-world, problem-based learning. STEM education removes the traditional barriers erected between the four disciplines by integrating them into one cohesive teaching and learning paradigm.

- **Task involvement**: When individuals are task-involved, they see more effort as leading to more mastery and higher ability.

Conceptual Framework

When examining experiential education, I provided examples as well as presented models to help understand how this type of instruction can be relevant and purposeful as well as reflective. I also discussed some of the challenges present in experiential education. I examined a ROV program operating within an elementary and secondary public school system. Examples of remotely operated vehicles within the marine industry were also presented. I also addressed the nature of the technology and the perception of technology usage involved in ROVs. In particular, I explored ROVs' impact on student interaction and interest and how that relates to the natural world. After identifying characteristics of at-risk students I discussed how success or lack of success in both the elementary and secondary school settings is measured. Because this is qualitative research, I tell the story of ROVs in an experiential education context within a specific Michigan school district. The voices of at-risk students were also captured in this case study. The conceptual framework that guided my research is shown in Figure 1.

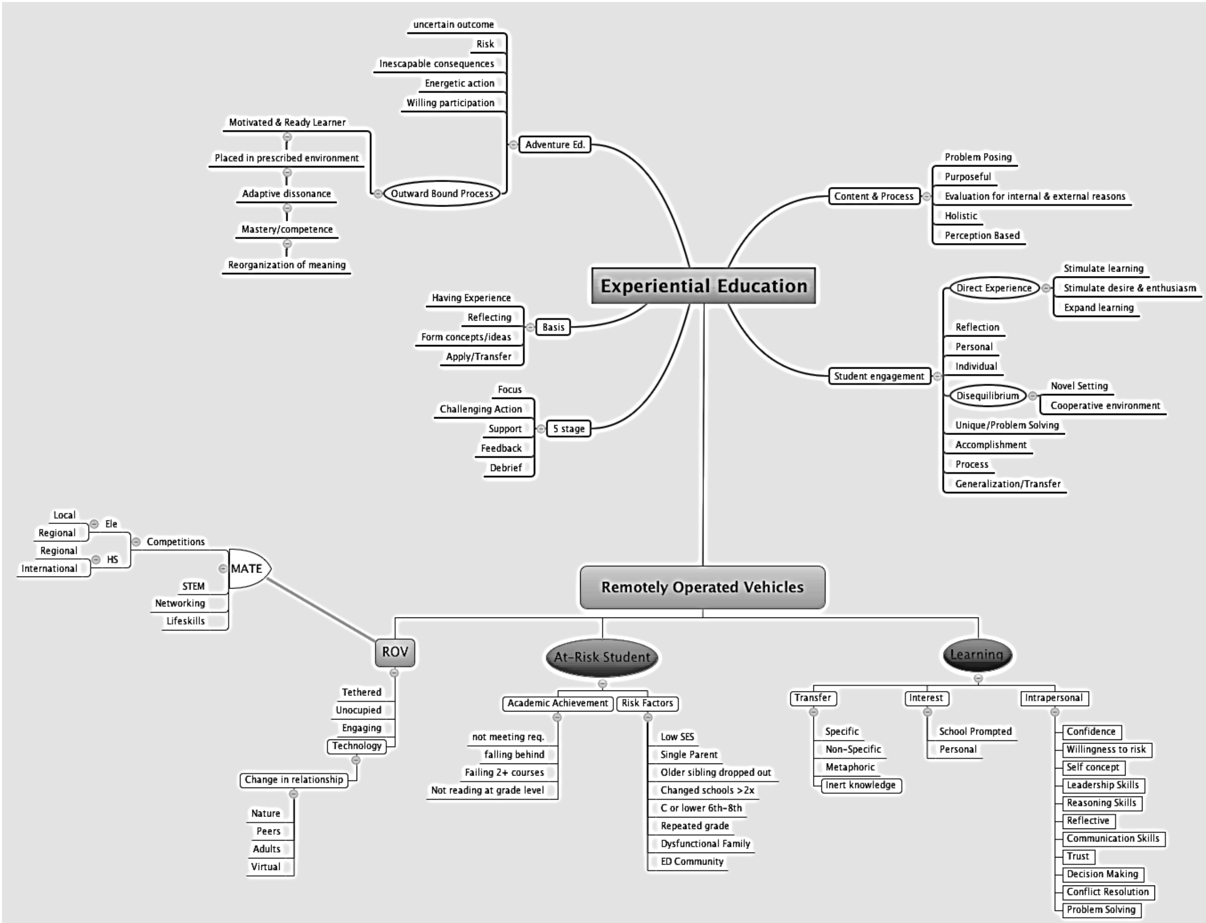

Figure 1. Conceptual framework of research.

The focus of this study was to explain the relationship between the use of ROVs in an experiential education context and at-risk student learning. To provide a context for this research, the literature review will focus on four areas: at risk students, experiential education, ROVs, and student learning.

Chapter Two: Literature Review

At-Risk Learners

What it means to be at-risk. The term *at-risk students* is used to describe students who are at risk of failing academically. The term at-risk does not have a single definition when applied to students in K-12 education. One could argue that all students are some way or another at-risk but, in essence, we are discussing students that are at-risk of exiting from their K-12 education before successfully completing it. These students may drop out, fail out, be pushed out, or age out of school (National Commission on Excellence in Education, 1983; Placier, 1993).

At-risk can describe a wide variety of students, including those who belong to ethnic or cultural minorities, academically disadvantaged, disabled, characterized by low socioeconomic status, and students with probationary status. The National Center for Education Statistics (Spring, 2010) listed the following characteristics that may lead to an at-risk label for students: low socioeconomic status, living in a single-parent home, changing schools at non-traditional times, below-average grades in middle school, being held back in school through grade retention, and having older siblings who left high school before completion. Thornburg, Hoffman, and Remeika (1991) also added the factor of negative peer pressure. Bulger and Watson (2006) specifically added students whose reading was below grade level.

Similarly, Ruff's (1993) found that risk factors such as language and cultural barriers, dysfunctional family dynamics, and residing in economically disadvantaged communities predicted adverse educational outcomes. Szaday (1989) stated that at-risk students are in a cycle of poor school attendance and achievement, behavior problems, and alienation from the school and the community. They are often involved in youth crime and, according the Thorley-Smith (1990), will ultimately enter the welfare and judicial processes.

Government programs. The federal government provides funding to states, which in turn provides specific funds to local school districts to help at-risk students. Most funding is included in the Title I program, which sends money to school districts based on census counts of children from low-income families and children in several smaller categories, such as homeless children. Most districts spend this money at the elementary level to hire teachers, purchase supplies, and fund intervention programs to help at-risk students (Michigan Department of Education, 2013).

Many schools use the Title I program funds to provide reading intervention for struggling students. It is the belief of many, including Thorley-Smith (1990), that early interventions for poor school achievement and behavior problems can stop this cycle and significantly improve outcomes for at-risk youth. At the secondary level, at-risk students are often placed into remedial programs in an effort to help them catch up with the required number of credits required to successfully complete school. Campbell (2009) stated that the remedial approach, which is incremental and sequential, often repeats the same unsuccessful learning process and leads to further frustration and ultimately to dropping out.

Remotely Operated Vehicles (ROVs)

A Remotely Operated Vehicle (ROV) is a tethered underwater vehicle or robot. ROVs are unoccupied, highly maneuverable, and operated by a person aboard a vessel or on shore. The tether consists of cables that carry electrical power and video and data signals back and forth between the operator and the vehicle (Marine Advanced Technology Education Center, 2011). Professional grade models such as those used in the Gulf of Mexico to stop the 2010 BP oil disaster cost millions of dollars. Models that can be made by K-12 students cost less than $100. As shown in Figure 2, student models can be made from common plumbing supplies such as PVC pipe and bilge pumps. These ROVs are controlled by students with an electrical box that looks similar to a remote control found at a hobby shop.

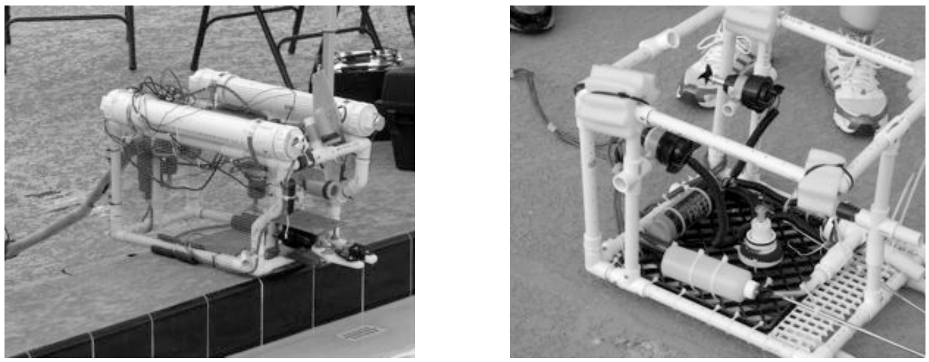

Figure 2. Two examples of student ROVs.

The Marine Advanced Technology Education Center (MATE) of Monterey Peninsula College, in an academic partnership with NASA, has provided and promoted "ROVs in a Bucket" that can be created by grade school students for under $125 (Levin, Trono & Arrasate, 2007, p. 1). These simple underwater robot kits are created primarily from PVC. They do not require glue or soldering and can be created in under an hour.

Levin et al. (2007) also stated that based on student workshops hosted by MATE, "virtually 100% of the workshop attendees indicated that the workshop was very worthwhile" (p. 7). The experiential learning techniques create ownership and lasting impressions of the lessons learned.

MATE hosts regional competitions throughout the world, including an international student ROV competition for middle school, high school, community college, and university students. Since 2002, thousands of students from around the world have participated in the competitions and improved their science, technology, engineering, and math (STEM) skills. Additionally, students have been exposed to a wide network of professionals working in research organizations, the government, branches of the military, and the marine industry. Kirkwood (2009) stated that at the competitions student teams compete to complete missions that simulate a high-performance workplace environment. In addition to the ocean workplace, Zande (2003) stated that ROV competitions help students develop desirable life skills such as “budgeting, setting deadlines, documenting procedures and results, and producing deliverables on time” (p. 85).

There is a current perception in the United States that the increase in the use of technology has led to a change in the relationship between individuals and nature (Louv, 2008). The perception is that individuals, children in particular, spend less time outside and spend more time separated from nature. Pergams and Zaradic (2008) argued that virtual experiences with nature sensationalize children’s perceptions of nature and decrease their accurate understanding of nature. Technology is often cited as a major player in the distancing of young people from the outdoors.

However, there is promising evidence that the technology involved with ROVs may contradict conventional wisdom and increase students’ desire to engage and explore nature. Gleason (2008) reinforced the need to use technology as a tool for connecting and engaging youth with nature and the outdoors. Gleason, Harmon, and Boakye (2006) found that students participating in ROV programs agreed that using the ROV helped them understand oceans better and understand nature. Furthermore, the researchers concluded that students found the ROVs not to be boring and that it also increased their interest in water environments. Further, that when using technology with environmental education programs, a multitude of positive indirect actions with nature often lead to increased direct interactions; this is especially true with students who, due to geography or finances, may have very limited opportunities to interact with the marine environment.

Experiential Education

Industrial model of education. School systems in the United States currently reflect the industrial model of education. Since the early 20th century, our schools have been based on the economics of scale. We see large centralized high schools, curricular standardization, an increase in state and federal regulation, and bureaucracy, with an increasing reduction of local control (Tyack & Cuban, 1997). There is also a lack of creativity and engagement in this model of instruction.

The assembly line workers who put doors on cars focus their time and energy on mounting the door correctly and sending it to the next spot on the line. The only time they think about the spots before them is if the door does not fit properly. The same thing happens in the education system. Teachers spend their time and energy focusing on the lessons for their content at that level. They are trying to keep up with the clock to move the student to the next grade or class before the bell rings. The only time the previous grade level or class is considered is when the student appears to be missing content (Baker, 2013).

Success in sports, arts, games, and even careers is often the result of being actively engaged or, more to the point, by doing (U.S. Department of Education, National Center for Education Statistics, 1995). However, for most students *doing* school is more about hoop-jumping and bubble-filling than it is a direct learning experience. Most school systems are based on a compliance model (Matheson & Shriver, 2005). To be successful, students learn about subject matter for a specific period of time, take a test, and move on to the next spot in line. The problem is that this model produces too many Pintos and Fairlanes. The world does not need or want an abundance of Pintos and Fairlanes. It wants models that are smarter and sleeker.

Resnick (1987) stated that there is a profound mismatch between the way students learn in the classroom and how they will later learn in the community. In most school settings, students are exposed to content in isolation. As a result, they don't see the relevance and cannot access what they know when confronted with an opportunity to transfer knowledge (Bransford, Brown, & Cocking, 2000). When instructed with experiential education methods, people can learn as workers or community participants with a need to know in order to get a job done, not just as students who need to take a test (Eyler, 2009)

Meaningful education. How do we make education meaningful? How do we help students transfer *school learning* to the world outside of school? What is the purpose of our educational system? These are questions that we have been wrestling with for a very long time (Brameld, 1962). Goals of education should include facilitating learning through experiences (McClellan & Hyle, 2012). These experiences form the base of experiential education. Experiential learning can happen in a variety of ways including intellectual development, civic and social responsibility, ethical development, career exploration, and personal growth (National Society for Experiential Education, 2011). Experiential education provides the opportunity to engage in reflective observation, to form abstract conceptualizations, and the opportunities to explore and apply ideas and ideals (Hirsch & Lloyd, 2005; Mitchell & Poutiatine, 2001).

Historical perspective. Experiential education is not new, it is hands-on learning and it is process-focused around engagement. This is not a new concept. Plato, Aristotle, Comenius, Rousseau, Pestalozzi, Dewey, and Piaget focused on the value of relevant and purposeful experience (Hunt, 1981). Philosophers and educators felt that education would build virtue, community, and self-awareness. People learn best by direct and purposeful contact with explicit learning experiences. The learning experiences should be realistic, physically active, cognitively meaningful, and emotionally engaging (Kraft & Sakofs, 1985).

Experiential education comes from the school of progressive educational theory. Historical figures such as Socrates, John Dewey, Kurt Hahn, Paulo Freire, Maria Montessori, and Dennis Littky personify experiential education (University of California: Science, Technology and Environmental Literacy, 2013). In ancient Greece, Socrates challenged the dominant educational practices of the Sophists who utilized a "pouring theory" of education, in which the teacher poured knowledge into his student like a vessel (Crosby, 1995, p. 6). Socrates advocated that students indeed had something to contribute to learning, and that it was the process rather than the product that was most valuable in education.

Hunt (1990) opined that, frustrated by the philosophical dualism of the day between rationalist strictly objective and empiricist strictly subjective views of epistemology, Dewey (1938) set out to confront this intellectual impasse in the hope of discovering a different or more cohesive way of perceiving the world. Dewey held the pragmatist's view that the worth of something is determined by its impact on everyday lived experience. He argued that a worthwhile philosophy was one that rendered ordinary life experiences more significant and more luminous. Dewey was concerned that in traditional education, learning had become separated from everyday experience. He argued that a theory of experience was needed to guide education, one that acknowledged the reciprocal, *organic* relationship between personal experience and education. Dewey felt experience provides a foundation for learning and gives learning meaning. He stated that experiential education is “in harmony with principles of growth” (p. 6).

Brazilian educator, Paulo Freire (1970) believed that “liberating education consists of acts of cognition, not transferals of information” (p. 77). Freire suggested a “problem-posing” theory of education in which teacher and student co-investigate problems that relate to themselves in the world, with a self-motivated desire for the “emergence of consciousness and critical intervention in reality” (p. 81).

Kurt Hahn, often hailed as the father of adventure education, founded Outward Bound in Wales in 1941. His philosophy centered on the importance of helping students to discover their true capabilities He believed that moral development should accompany academic learning. Hahn spread his ideas of experiential education throughout Europe, and in the 1950s Will Miner began the process of bringing Outward Bound to the United States (Outward Bound, U.S.A., 2007).

During the 1970s and 1980s, Dennis Littky created schools in rural New York and New Hampshire that turned “ineffective and poorly managed” schools into schools that graduated over 95% of their students and sent over 90% of those students on to higher education (Big Picture Company, 2009). During the 1990s, Littky went on to found the Metropolitan Regional Career and Technical Center in Providence, Rhode Island (known as *The Met*) and The Big Picture Company, an independent nonprofit education reform organization (Big Picture Company, 2009). In the Big Picture Schools, teachers work with small groups of students for four years. Their job is to do “whatever’s necessary” to help students grow and be educated (Sparks, 2005, p. 39). By 2008, more than 60 Big Picture schools were in operation in 14 states, supported by investments in Big Picture Learning by the Bill & Melinda Gates Foundation (Big Picture Company, 2009).

21st century learning. Since the start of the 21st century, we have seen a further push in college readiness programs and increased standardization of content, as witnessed in the Core Content Standards (Applebee, 2013). We are not missing what to teach, but how to teach. Experiential education provides that missing component. It is truly a way of doing; not something that you do (Collinson, Panicucci & Prouty, 2007). Experiential education helps students link experiences with theory and thereby deepen their understanding and ability to use what they know (Eyler, 2009). Conrad and Hedin (1982) emphasized that students "are in new roles featuring significant tasks with real consequences, and where the emphasis is on learning by doing with associated reflection" (p. 3).

Quality experiential education is teaching students core academic subjects such as math, science, and reading as well as essential life skills such as communication, teamwork, problem-solving, and determination. All aspects of experiential education are linked together by creating a project, which can take place in classrooms and schools from kindergarten through college. The project can focus on almost anything, as long as the instructor makes it educative or meaningful and engaging. The instructor's role is very important. The instructor needs to guide the process to avoid creating an experience that is *miseducative.* Dewey (1938) described a miseducative experience as one that arrests or distorts the growth of further experience. A miseducative experience may breed callousness, insensitivity, or unresponsiveness.

Beard and Wilson (2002) claimed that when learners are engaged in experiential education they see the connections and are more likely to retain the information and to transfer that knowledge. In addition, teachers are better able to transfer new knowledge that students learn from these intimate, experiential settings. To be successful in the global economy, people need to be creative and engaged in what they are doing. Even though Michigan has some of the highest unemployment numbers in the country, employers state "there is a significant mismatch in Michigan in the skills of its workers and the skills employers need" (Haglund, 2011, "*Jobs available, skills are not,"* para. 14). The education system must move from a system of compliance to a process of creativity and engagement.

Regardless of the activity or exercise, if a person is engaged, the time appears to go by quickly, meaning is ascribed, and retention is high. This concept is not limited to education or leisure. In 2006, Gallup examined 23,910 businesses to compare engagement scores. They found businesses with engagement scores in the top half had 27% higher profitability than those in the bottom half. Gallup also found that engagement levels can be predictors of absences, with more highly engaged employees taking an average of 2.7 days per year, compared with disengaged employees taking an average of 6.2 days per year (Little & Little, 2006).

The experiential learning cycle. The activity or adventure is not in and of itself experiential education but is one phase of a learning cycle. The experiential learning cycle provides a lens to examine the process of experiential education. Henton (1996) stated that it "begins with the activity, moves through reflection, then to generalizing and abstracting and finally to transfer" (p. 39). Shown in Figure 3, this cyclical process repeats, as learning identified in the transfer phase applies to the next activity. *T*he experiential learning cycle can be applied to the learning environment using ROVs.

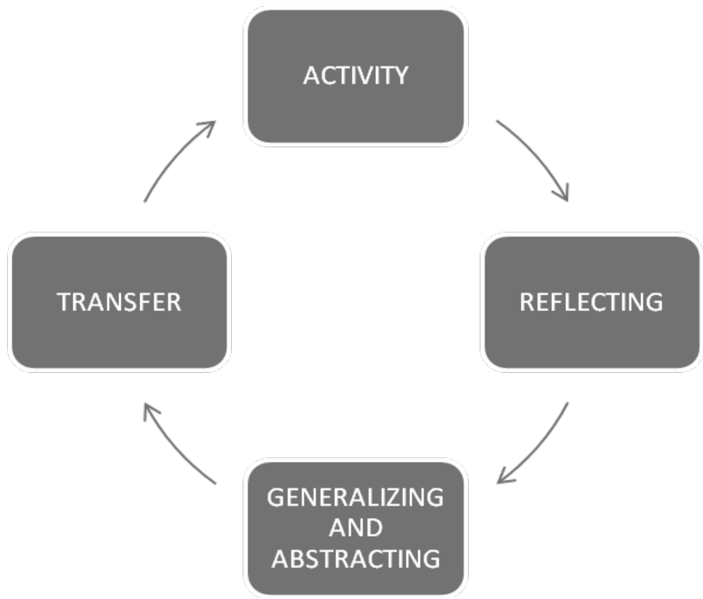

Figure 3. Experiential learning cycle.

1. **Activity:** The elementary students working with ROVs were given a motor and told to make their ROV move forward. The primary goal of the activity was to initiate as may connections with the content as possible. What affects movement? Where to place the motor? How to attach the motor? Which direction should it face? During this first phase “doors open to the student’s many intelligences” (Henton, p. 40) such as logical/mathematical, visual/spatial, kinesthetic, interpersonal, intrapersonal, verbal/linguistic, and so forth. The activity portion allows students to interact with the material according to their own strengths. Students learn that often there are many ways to achieve a goal.

2. **Reflection:** The second phase involves time for questions. Students are guided to review the facts of what took place during the activity: Did the ROV move forward? Who did which jobs? Did it matter where the motor was placed? This is a time where the teacher can

guide the students to clarify facts. Henton stated "the reason for clarifying facts is not substitute facts for learning, but to pave the road to in-depth learning with accurate information about the beginnings of a metacognitive framework" (p. 41). During this time, it is also important to focus on the *what* of the activity. The what allows for students to compare their perceptions with others and see if they fit. It is a time for children and adults to validate experiences. Learners can then move ahead to assess, evaluate, compare, contrast, and later to apply new knowledge.

3. **Generalizing and abstracting:** The third phase allows for making connections between ideas and experiences. Students look at commonalities and differences to apply broadly. Questions such as: how, what if, and so what often take place at this stage. In the case of ROVs, students can ask if the same solution would work for getting the ROV to rise. What about turning? Are we sharing responsibilities? Are some people doing more than others? This type of questioning is about analysis. Students examine what they have learned and think about where to go next.

4. **Transfer:** The fourth phase is a return to action. Students take what they have learned from the first three phases and apply that new knowledge. The transfer step often leads right into the activity phase. The ROV students now need to figure out how to make their ROV turn. They transfer the knowledge gained from their experience with forward thrust and incorporate new principles of motion. The cycle of new learning and reflection continues as the motions of turning bear similar but different success and obstacles. When the students have discovered how to make their ROV move forward and turn, their next challenge is to navigate the ROV through a mission. The learning cycle continues.

Kolb's model of learning styles. Kolb (1984) defined learning as "the process whereby knowledge is created through the transformation of experience. Knowledge results from the combination of grasping and transforming experience" (p. 41). He built upon the experiential model by incorporating learning styles, as shown in Figure 4. Kolb's model recognized that learning is complicated, often requiring abilities that are polar opposites. He stated that the learner must continually choose which set of learning abilities he or she will use in a specific learning situation (Kolb, Boyatzis, & Mainemelis, 2001).

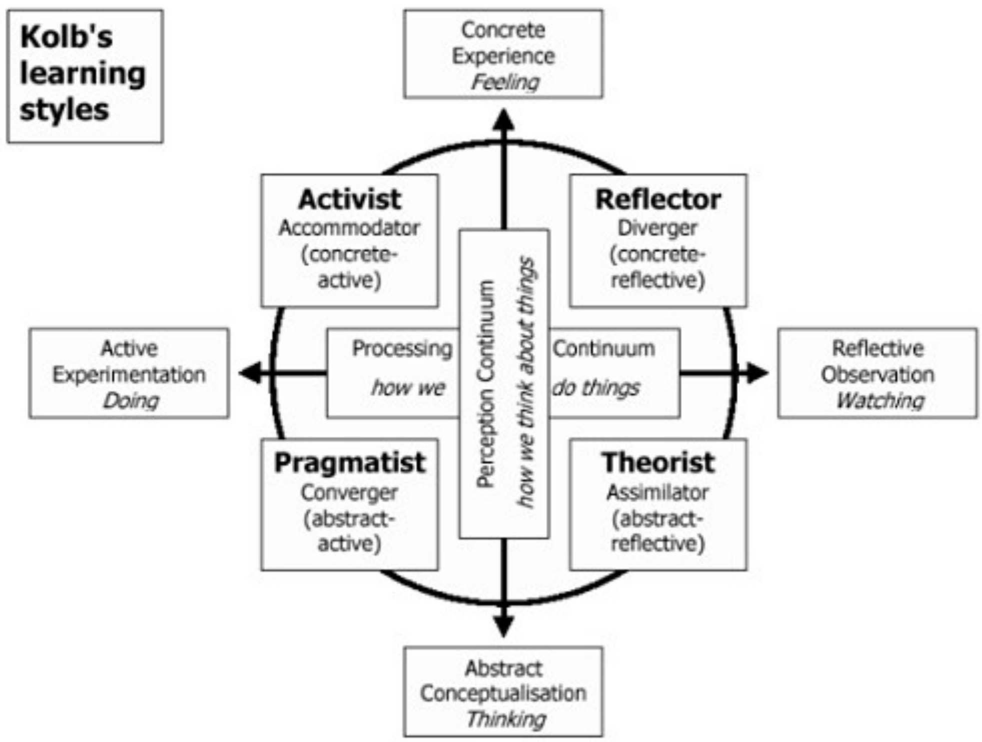

Figure 4. Kolb's learning styles.

The perception continuum is represented on the vertical axis, which expresses how we think about things. Perception of new information can occur on a feeling level through experiencing in a concrete manner. At this end of the spectrum thinking is more tangible; we rely on our senses and immerse ourselves in concrete reality. At the other end of the spectrum, learners perceive new information through a cognitive symbolic representation;

this is known as abstract conceptualization. Here, learners perceive new information through analysis or systematic planning.

In relationship to ROVs, analysis or systematic planning is seen when students are thinking about designing their ROVs. Some students prefer to go right to the box of supplies and start sticking parts together. They use their feelings to process and make decisions as they are going along. Other students prefer to think through what a ROV should be and be able to do. They think through such concepts as strength, mobility, and buoyancy. A plan is conceived and refined.

The processing continuum is represented on the horizontal axis, which expresses how we transform or do things. Some learners prefer to observe or watch others who are involved in the experience and reflect on what happens. Others would rather jump right in and start doing things. The watchers favor reflective observation, while the doers favor active experimentation. While building ROVs, some students prefer to provide suggestions to enhance the design, as others are processing while constructing.

Kolb et al. (2001) identified four learning styles built from the two learning abilities spectrums. Using ROVs as an example,

1. **The Reflector** is based on a diverging style of learning. The dominant learning abilities are Concrete Experience and Reflective Observation. This learning style lends itself to viewing concrete situations from many points of view. People who work well in this domain often prefer to work in groups. They are often open-minded and enjoy brainstorming or gathering information and ideas from several points of view. When working in small groups, reflectors listen and consider multiple perspectives. In the ROV groups, students

shared their initial body designs. Reflectors would suggest taking parts from one design, such as the motor placement, and combine them with another design, such as frame shape.

2. **The Theorist** is based on an assimilating style of learning. The dominant learning abilities are Abstract Conceptualization and Reflective Observation. People with this learning style are best at processing a wide range of information and putting it into a concise and logical format. They often prefer readings and models as well as having time Theorists took the time to consider the mission of the ROV and suggested concepts to be built. For example, if the ROV was required to pick up an object from the bottom of the pool, the theorist would suggest ideas for different types of manipulators to achieve the goal.

3. **The Pragmatist** is based on a converging style of learning. The dominant learning abilities are Abstract Conceptualization and Active Experimentation. People with this learning style are best at finding practical uses for ideas and theories. They are often problem-solvers who enjoy labs, simulations, and practical applications. The pragmatists are able to examine the available materials and come up with construction ideas. Pragmatists were witnessed utilizing available bolts and washers to adjust the ballast in the ROV. They were also the students who figured out ballast fine-tuning by removing caps and adding small amounts of water to the tubes.

4. **The Activist** is based on an accommodating style of learning. The dominant learning abilities are Concrete Experience and Active Experimentation. People with this learning style do best with hands-on experiences. They often act on *gut feelings* as they carry out an action. They often rely on people for information, as opposed to their own analysis and prefer working with others to accomplish a goal or assignment. The activists were quite often the pilots. They felt comfortable grabbing the controls and attempted to drive their way

out of problems. They did best using trial and error, as opposed to examining what went wrong and devising a new strategy.

Adventure education. Adventure education is another example of experiential education that engages learners in ways that are not typically found in a traditional classroom. When people think of adventure education, images of high ropes courses, backpacking, and hiking often come to mind. However, Prouty (2007) defined adventure education as, “Direct, active, and engaging learning experiences that involve the whole person and have real consequences” (p. 12).

Project Adventure is a non-profit organization that has been helping to facilitate adventure education experiences since 1971. Their work is synonymous with experiential education. They define adventure as “a way of doing; not something that you do” (Project Adventure, 2013, Glossary of Terms). Project Adventure also simplifies the experiential learning cycle into what they call the *what* cycle, which allows authentic debriefing while in the field (See Figure 5).

Project Adventure stated that a class becomes an adventure for students if an element of surprise or risk exists. Adventure exists when there is engagement, and engagement comes

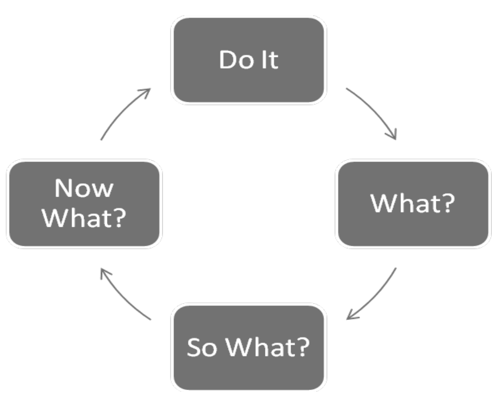

Figure 5. Project Adventure’s *What* cycle.

from providing students with experiences that are unique and relevant. Adventure is about taking risks; the risks may or may not be actual physical or emotional risks. Horwood (1999) defined five characteristics that qualify an activity as adventurous. These characteristics are: uncertain outcome, risk, inescapable consequences, energetic action, and willing participation. By this definition, adventure education can be used in a classroom or school setting and does not necessitate adventurous outdoor activities. Remotely operated vehicles (ROVs) will be the catalyst of adventure for this study.

Based on Horwood's (1999) criteria, student involvement with ROVs may be characterized as adventurous. Due to all of the variables involved in the operation of the vehicle and the conditions of the location of operation, the outcome is always uncertain. There is emotional risk involved when working with a group and competing against others. The consequences are inescapable. As students willingly design, build, refine. and compete with their ROV, the environment is energetic and emotional.

Student Learning Outcomes

Too often, success in school is measured by knowledge acquisition and the repetition of the information. Experiential education aims at helping the student be able to discover and apply knowledge. The literature on experiential education strongly supported learning transfer as a key factor in a program's success. Gass (1985) explained three types of transfer.

- Specific transfer: Reapplication of a finite physical skill to a new but related situation.
- Non-specific transfer: Transferring a learned skill to a new situation entirely.
- Metaphoric transfer: Generalize learning from a given experience and to apply a related skill to a completely different context elsewhere in life.

A general finding in transfer studies is that students are often unable to apply their in-school learning to real-world problems or in novel contexts. This problem is often referred to as the "inert knowledge problem" (Bereiter & Scardamalia, 1985 (p. 65); Brown & Campione, 1980). It is important to recognize that little research has actually examined the transfer of school learning to the out-of-school domain. Barnett and Ceci (2002) commented, "For most of the studies reviewed here, transfer and training were conducted in the same macro context, usually the school" (p. 623).

School-prompted interest occurs when a student develops an interest in a topic through school learning and continues to pursue this interest outside of school. Bergin (1992) interviewed 66 high school students and found that 47% reported no instances of school-prompted interest, and 38% reported only one. In a later survey study, Bergin (1996) found 50% of the students did not name a single instance of school-prompted interest.

Experiential education has shown promising results in producing intrapersonal outcomes. These outcomes are related to emotional and individual development and may include new confidence in oneself, increased willingness to take risks, improved self-concept, enhanced leadership skills, increased logical reasoning skills, and greater reflective thinking skills. Interpersonal outcomes relating to social and group skills may include enhanced cooperation, more effective communication skills, greater trust in others, increased sharing of decision-making, new ways to resolve conflicts, improved problem-solving skills, and enhanced leadership (Priest & Gass, 1997; Pugh & Bergin, 2005)

One of public education's primary goals is to help students transition into productive and career oriented work lives. A growing body of research literature suggested that experiential education activities and experiences have the potential to be effective at achieving this goal (Baldwin et al., 2004; Hattie, Marsh, Neill, & Richards, 1997). Experientially based programs that directly engage the student in the learning process seem to promote learning. The promotion of learning leads to an increase of skills that can be transferred to career lives.

Experiential learning is designed to advance students' learning and address academic goals and to inspire student development and awareness of the learning processes (Giddings, 2003; Kolb, 1984). Priest and Gass (1997) suggested that experiential learning is a multi-faceted educational approach that involves "learning by doing with reflection" (p. 24), emphasizing the belief that people construct meaning best through direct and purposeful contact with their learning experiences.

Conrad and Hedin (1980) tested 1000 students from 27 different programs to determine psychological, social, and intellectual effects of experiential education on secondary school students. Their research cited positive development in the areas of moral reasoning and self-esteem, as well as positive growth in the level of social and personal responsibility, attitudes toward adults, attitudes toward others, and toward being active in the community. Intellectually, there was an increase in the amount of knowledge that students perceived they had learned in the experiential program, with particular emphasis on improved problem-solving abilities.

The literature review for this study focused on experiential education, at-risk students, and remotely operated vehicles (ROVs). A historical perspective of experiential education and 21st century demands were summarized. Adventure education and student outcomes were addressed. The experiential learning cycle and Kolb's learning styles cycle were outlined and related to ROVs. At-risk learners were defined, examples of programs were provided, as were examples of success through engaging activities and tasks. The proceeding chapters will examine a group of at-risk learners experiencing education through the remotely operated vehicles.

Chapter Three: Research Methods

Research Tradition

Qualitative methods were used in the conduct of this study.

> ...analyses of person, events, decisions, periods, projects, policies, institutions or other systems which are studied holistically by one or more methods. The case that is the subject of the inquiry will be an instance of a class of phenomena that provides an analytical frame–an object–within which the study is conducted and which the case illuminates and explicates. (Thomas, 2011, p. 23)

Miles and Huberman (1994) defined the case as "a phenomenon of some sort occurring in a bounded context" (p. 25). Adelman, Jenkins, and Kemmis (1983) stated, "The most straightforward examples of a bounded system are those in which boundaries have a common sense obviousness" (p. 3). In this case, it was those involved with at-risk students and ROVs in education.

Cronbach (1975) said that a case study is a research design that is "interpretation in context" (p. 123). I interpreted the learning experiences of those involved with experiential education, ROVs in particular. A case study was appropriate in this situation because of the context, creativity, and innovation of ROVs and at-risk students in education. Because the people and the learning being analyzed were bound within the context of the public school system, the organizational structure of the public school system was also analyzed.

A case study allows for the analysis of organizational theory. Finally, according to Stake (1995), a case study also allows for "previously unknown relationships and variables to emerge leading to a rethinking of the phenomenon being studied. Insights into how things get to be the way they are can be expected to result from case studies" (p. 47). In this study I examined how and why we educate students, in particular at-risk students. Is there a relationship between content, instruction, and success?

Research Design

During my research, I explained what was taking place in the field and built a theory as to why the phenomenon was taking place, a process which could be referred to as a form of grounded theory. Charmaz (2006) advocated writing, "preliminary analytic notes called memos" about the data (p. 5). These data fall into tentative analytic categories, or codes. The codes culminate in a grounded theory, or an abstract theoretical understanding of the studied experience.

Yin (1981) stated that an explanatory case study is an empirical inquiry that "investigates a contemporary phenomenon within its real-life context; when the boundaries between phenomenon and context are not clearly evident; and in which multiple sources of evidence are used" (p. 23). Yin further stated that there are six sources of evidence for case studies: "interviews, documents, archival records, direct observation, participant-observation, and physical artifacts" (p. 84). Interviews were conducted with people within the field. Observation, both direct and participant, took place in the field, and I also considered documents, artifacts, and archival records as objects from the field.

Setting

In this qualitative research I examined the impact that a specific form of experiential education had on at-risk students at a rural Michigan elementary and high school. Chapter Four comprises the story of how a landlocked school district, which does not even have a swimming pool, introduced, developed, and competed with underwater remotely operated vehicles. The emerging themes of this research are discussed in Chapter Five.

Participant Selection

Students deemed *at-risk* of academic failure and who had experience using Remotely Operated Vehicles (ROVs) were selected to participate in this study. Students selected possessed at least one of the at-risk characteristics as defined by Bulger and Watson (2006) and Aud et al. (2010): low socioeconomic status, living in a single-parent home, changing schools at non-traditional times, below-average grades in middle school, being held back in school through grade retention, having older siblings who left high school before completion, and not reading at grade level. This form of sampling is considered purposive sampling. The participants were purposively selected because they met the criteria of being involved with ROVs and/or were at-risk learners.

Legacy Elementary School formed a ROV club based on participation in the MATE's Scout class (Marine Advanced Technology Education). These students gained initial expose to ROVs as fourth-grade students in Will Jackson's class where they had the opportunity to learn about and build ROVs. As fifth-graders and members of the ROV club, they became a three-person team responsible for meeting the requirements for MATE's Scout class competition.

After an artifact analysis, at-risk students from the Introduction to Robotics class offered at Springfield High School were selected to participate in this study. These students also competed in the MATE event, but at the Ranger class level. I interviewed current students and a Springfield alumnus who competed in an international MATE event. Support interviews from John Jameson, the teacher and coach of the class, also took place.

Data Collection

Interviews. Initial interviews were conducted with Will Jackson's at-risk fourth-graders who were involved in the ROV club. Supplementary interviews were conducted with specific students as well as the guardians and teachers of the selected students and club coaches.

Focused interviews were conducted with students, teachers, parents, administrators, and professionals involved with ROVs and at-risk students. Interview questions were open-ended allowing me to ask for facts and opinions about events and situations. However, as advocated by Yin (1981), they "follow a certain set of questions derived from the case study protocol" (p. 89). Thomas (2011) also referred to this type of interviewing as semi-structured, a process that provides structure but not an obligation to go through the points in order. It acted as a "reminder of what you want to cover" (p. 163).

Most of the interviewees were affiliated with Springfield Public Schools, where I had access through my position as an employee in the district. Due to the potential hierarchical or power dynamics associated with my position, I made extra efforts to be non-threatening. I was calm, reassuring, and attuned to the respondents (Glesne, 2006). Furthermore, I followed Fontana and Frey's (1994) advice to "show (my) human side and answer questions and express feelings" (p. 370). My goal was to give the participants my undivided attention, and to indicate that their point of view on the topic was paramount to my understanding of the topic. All of the initial interviews were face-to-face. Some of the supplementary interviews and fact checking were done by phone calls and e-mails.

Interview questions focused on a particular issue were described by Glesne (2006) as topical interviewing. The goal of the interviews in this study was to determine whether experiential education in the form of ROVs had an impact on at-risk student learning. Rubin and Rubin (2011) compared a topical researcher to that of a photographer "selecting and interpreting details and creating an image from them" (p. 32). Interview protocols for students, instructors, family members or guardians, and individuals are shown in appendices A, B, C, and D respectively.

Fieldwork. Wolcott (1995) defined fieldwork as a form of inquiry that requires a researcher to be immersed personally in the ongoing social activities of an individual or group. Fieldwork allowed me to ask questions of the students involved with ROVs (Hatch, 2002).

Observations. When doing fieldwork, Spradley (1980) recommended descriptive observations, which are usually carried out observing everything, through the heightened awareness of the senses. Spradley suggested using the framing question, "What is going on here?" Although a central question, it is not the only one to ask while in the field. There, I observed participants of the Legacy ROV team and members of the high school robotics class. I also traveled to Tawas Bay, MI to observe the Midwest Regional ROV competition.

Spradley (1980) stated that there are nine categories of phenomena that might occur in any setting of human interaction or social setting. He provided a matrix shown in Figure 6, which comprises the nine categories to show the range of questions that the researcher may ask or describe.

	SPACE	OBJECT	ACT	ACTIVITY	EVENT	TIME	ACTOR	GOAL	FEELING
SPACE	Can you describe in detail all the *places?*	What are all the ways space is organized by objects?	What are all the ways space is organized by acts?	What are all the ways space is organized by activities?	What are all the ways space is organized by events?	What spatial changes occur over time?	What are all the ways space is used by actors?	What are all the ways space is related to goals?	What places are associated with feelings?
OBJECT	Where are objects located?	Can you describe in detail all the *objects?*	What are all the ways objects are used in acts?	What are all the ways objects are used in activities?	What are all the ways objects are used in events?	How are objects used at different times?	What are all the ways objects are used by actors?	How are objects used in seeking goals?	What are all the ways objects evoke feelings?
ACT	Where do the acts occur?	How do acts incorporate the use of objects?	Can you describe in detail all the *acts?*	How are acts a part of activities?	How are acts a part of events?	How do acts vary over time?	What are the ways acts are performed by actors?	What are all the ways acts are related to goals?	What are all the ways acts are linked to feelings?
ACTIVITY	What are all the places activities occur?	What are all the ways activities incorporate objects?	What are all the ways activities incorporate acts?	Can you describe in detail all the *activities?*	What are all the ways activities are part of events?	How do activities vary at different times?	What are all the ways activities involve actors?	What are all the ways activities involve goals?	How do activities involve feelings?
EVENT	What are all the places events occur?	What are all the ways events incorporate objects?	What are all the ways events incorporate acts?	What are all the ways events incorporate activities?	Can you describe in detail all the *events?*	How do events occur over time? Is there any sequencing?	How do events involve the various actors?	How are events related to goals?	How do events involve feelings?
TIME	Where do time periods occur?	What are all the ways time affects objects?	How do acts fall into time periods?	How do activities fall into time periods?	How do events fall into time periods?	Can you describe in detail all the time *periods?*	When are all the times actors are "on stage"?	How are goals related to time periods?	When are feelings evoked?
ACTOR	Where do actors place themselves?	What are all the ways actors use objects?	What are all the ways actors use acts?	How are actors involved in activities?	How are actors involved in events?	How do actors change over time or at different times?	Can you describe in detail all the *actors?*	Which actors are linked to which goals?	What are the feelings experienced by actors?
GOAL	Where are goals sought and achieved?	What are all the ways goals involved use of objects?	What are all the ways goals involve acts?	What activities are goal seeking or linked to goals?	What are all the ways events are linked to goals?	Which goals are scheduled for which times?	How do the various goals affect the various actors?	Can you describe in detail all the *goals?*	What are all the ways goals evoke feelings?
FEELING	Where do the various feeling states occur?	What feelings lead to the use of what objects?	What are all the ways feelings affect acts?	What are all the ways feelings affect activities?	What are all the ways feelings affect events?	How are feelings related to various time periods?	What are all the ways feelings involve actors?	What are the ways feelings influence goals?	Can you describe in detail all the *feelings?*

Figure 6. Spradley's (1980) nine categories of phenomena.

Objects. Another source of primary evidence comes in the form of objects. Whether electronic or physical, the collection and analysis can be useful. Yin (2011) stated, "collecting objects (e.g., documents, artifacts, and archival records) in the field is invaluable but also time-consuming (p. 148)." Consequently Yin recommended exerting great care while deciding what needs attention and the amount of time dedicated to the objects. I analyzed data such as demographic information, class syllabus, presentations, photographs, and social media such as Facebook, Twitter, and web sites.

Data Analysis

The data were grouped into topics and sub-topics and discussed in thick, rich descriptive detail (Geertz, 1973; Fraenkel & Wallen, 2005). This theory of interpretation “goes beyond the mere or bare reporting of an act (thin description), but describes and probes the intentions, motives, meanings, contexts, situations and circumstances of action” (Denzin & Lincoln, 1998, p. 39). Dependability, or trustworthiness and authenticity, was ensured through the use of debriefing and triangulation techniques "for cross-checking, or for ferreting out varying perspectives on complex issues and events” (Wolcott & Legg, 1988, p. 14). Maxwell (2009) provided a seven-point checklist to help ensure validity. Validity in this case being synonymous with dependability and trustworthiness:

1. Intensive long-term [field] involvement – to produce a complete and in-depth understanding of field situations, including the opportunity to make repeated observations and interviews;
2. Rich data – to cover fully the field observations and interviews with detailed and varied data;
3. Respondent validation (member checking) – to obtain feedback from the people studied, to lessen the misinterpretation of their self-reported behaviors and views;
4. Search for discrepant evidence and negative cases – to test rival competing explanations;
5. Triangulation – to collect converging evidence from different sources;
6. Quasi-statistics – to use actual numbers instead of adjectives, such as when claiming something is “typical,” “rare,” or “prevalent”; and
7. Comparison – to compare explicitly the results across different settings, groups, or events. (p. 244-245)

I used peer debriefing with a fellow doctoral student and school superintendent to ensure validity and credibility. Erlandson (1993) promoted peer debriefing as an opportunity to "allow a professional outside the context and who has some general understanding of the study to analyze materials, test working hypotheses and emerging design, and listen to the researcher's ideas and concerns" (p. 140).

Technological assistance in the form of digital recordings, word-processing, and concept maps was also used (See Appendix E). Dedoose software, designed to assist in codification and integration of data was used to identify specific observable actions, characteristics, and themes. However, Wolcott's (1995) disclaimer stated, "no program can be developed to do the mindwork necessary to interpret and analyze qualitative data" (p. 155).

The Dedoose software functioned primarily as a database and cloud map, as opposed to software that identified codes based on word count. I followed grounded theory concepts of Glaser and Strauss (1967) to assist in the data reduction or coding process. I found the series of grounded theory videos by Gibbs (2010) to be extremely helpful throughout the coding and data reduction process. The open coding stage involved transcribing and analyzing the interviews, looking for categories of information. Further reduction in the axial coding stage led to identification of interconnecting themes between the participants and ultimately, to their story of experiential learning.

Ethics

Ethical consideration was present throughout my research. Reflexivity, describing to the extent possible the interactive effects between participants and myself including the social roles and advocacy positions (Yin, 2011), was disclosed. All research met Eastern

Michigan University's Human Subjects Review Board requirements. (See Appendix F) Informed consent forms were provided and completed by each participant prior to the interview (See Appendix G). The consent form clearly stated that the participants were voluntary. Extreme care was taken to minimize harm (Denzin and Lincoln, 1998). The participants were carefully and truthfully informed about the research, and their right to privacy was met by providing pseudonyms and securing my research material.

Limitations and Delimitations

Although I am close to the concept and support the ideals of experiential instruction, I am not involved in the daily instruction of the students or the ROVs. I recognized that my position of authority may have limited initial responses during interviews, but I was able to overcome the potential positional power imbalance through refined interview techniques and spending time with the participants in the study.

Current research on experiential education has many limitations and is open to skepticism. Henry (1989) stated that the field of experiential education is diffused and thinly spread across so many areas that it not only lacks a concise and inclusive definition, but also a common language with which to articulate one.

There is also the problem of the lack of measurement instruments able to directly test students' academic learning of facts or concepts (Conrad & Hedin, 1980). Experiences are complex, never complete, and difficult to measure. Bell (1993) questioned how people can refer to experiences as generic and reproducible. She asserted that "experiences are contingent; and that interpretations can change" (p. 22).

Much of the research and literature on experiential education is qualitative, partly due to the difficulty in quantifying experiential education. This is often a challenging undertaking given the diversity of variables such as participants, program designs, and individual program experiences. Attending to the most likely confounding variables during the project design phase is critical (Ewert & Sibthorp, 2009). Each of these potentially confounding variables can influence what and how participants learn from an experiential education program and what they report they learned or experienced from that program.

Although there are a substantial number of potentially confounding variables, many are consistent with the traditional threats to internal validity, such as selection bias, maturation, intervening effects, changes in measurement and mortality (Trochim & Donnelly, 2007). One of the major challenges confronting experiential education researchers is accounting for multiple confounding variables while being simultaneously and logistically limited in how they might control for these influences. Field-based researchers are often forced to make choices between what is ideal and what is feasible, given the resources available to conduct the study. Figure 7 shows the confounding variables that tend to be present in experiential education research and evaluation settings.

Precursor *(Before the Experience)*	**Concomitant** *(During the Experience)*	**Postexperience** *(After the Experience)*
Prior knowledge and experience	Course specifics	Social desirability
Demographics	Group characteristics	Postexperience euphoria
Pre-experience anxiety	Situational impacts	Postexperience adjustment
Pre-experience motivations and expectations	Frontloading for evaluation	Response shift bias
Self-selection into a specific program/course or experience		

Figure 7. Confounding variables.

Chapter Four: Growing Experiential Education in the Great Lake State

Background

Events related to the ROV experience in the Springfield Public Schools are described in this chapter, including an introduction of the setting and participants involved in this research. This story is the result of months of analysis, weeks of observation, and days of interviews and, although the story is true and accurate, pseudonyms were used throughout this research. An analysis of underlying themes follows in Chapter Five.

Michigan is known as the *Great Lake State,* the only state in the nation that comprises two peninsulas. From anywhere in Michigan, you are within 85 miles of a Great Lake (Michigan Department of Transportation, 2012). However, for many Michiganians, traveling those 85 miles could take a lifetime. This study examined a group of students who not only traveled to a Great Lake, but also to a gulf and an ocean.

Springfield Public Schools

Students attending Springfield Public Schools are close to the 85-mile distance from one of the Great Lakes. Many of the students have never been to a Great Lake. As a land-locked school district, Springfield is in a rural location that spans four counties: Eaton, Ingham, Calhoun, and Jackson. Serving more than 1700 students, four schools compose the school district: Jones Elementary School (K-2), Legacy Elementary School (3-5), Springfield Middle School (6-8) and Springfield High School (9-12).

The school district is the only unifying entity of the area; no industry, business, or social group in the surrounding geography gathers people together as does the school district. Springfield is a bedroom community whose students come from families, which for the most part, commute to larger cities. Therefore, there are few private businesses or civic groups that have a dramatic influence over the district. Generally the parents want their kids to be out of the house, to be happy, and to receive a comprehensive education.

Well over 90% of the students finish their K-12 experience at Springfield Public Schools. From there, about 40% will go to their county's community college. Lansing and Jackson Community Colleges receive the lion's share. Roughly 30% of the students will go to a comprehensive college such as Central, Eastern, Western, Grand Valley, and Ferris. Ferris will also get most of the technical students who pursue a bachelor's degree; although an increase in the number of students attending Lawrence Tech has been taking place in recent years. About 2% of the students go to the University of Michigan or other research university.

Close to 15% of the students who attend Springfield Public Schools will exit into the workforce, with an almost even split between manufacturing, service, and trade industries. Even though it is considered a rural school district, only about 3% of the graduates enter into agriculture. However, close to 5% of the high school graduates just exist. They don't really have a job or their own residence, nor is it clear how they spend the hours in their day. It is assumed that in some capacity they are receiving support from social agencies. The military, in particular the Army and Marines, accept 5% of the students into their ranks.

Culturally, Springfield Public Schools comprises people of mainly Western European descent. The largest common denominator is working class people who have come north for jobs in the manufacturing sector. Most parents work jobs, as opposed to having careers. Many of the jobs are within the auto industry and light manufacturing. Some parents are affiliated with state universities, usually as support staff.

When walking the halls of the schools, it is uncommon to see people wearing suits. Parents wearing business attire is rare; uniforms and other work clothes are more the norm. Shirts and ties generally complement the attire of the superintendent and principals, whereas teachers wear casual clothes and, amongst the support staff, jeans and t-shirts are common.

Will Jackson Brings ROVs to Springfield

Many dedicated people serve in the Springfield Public Schools. In particular, this paper examined teachers in the Legacy Elementary School and Springfield High School. Will Jackson is a fourth-grade teacher at Legacy Elementary School. He is the type of teacher who is always looking for new and exciting activities for his students. Three years ago, Will attended a statewide technology conference. He was intrigued by a presentation led by a middle school teacher from Muskegon, who was using Remotely Operated Vehicles (ROVs) with his students to study the local salmon population. This form of experiential education grabbed Will's attention. Because he was responsible for teaching his students about the Great Lakes, Will determined to bring ROVs to Springfield.

Will began teaching a six-week ROV unit to his 28 students, during which time the students designed, built, tested, and competed with ROVs. Will stated that when students entered his room during those six weeks, they were "fired up, every day." He enjoys teaching with ROVs because it has shown him "that I need to do more projects in the classroom." He realizes that this form of instruction "is not just ROVs, it's creating". Comparing teaching geometry through building an ROV to the math book, Will observed:

> Most of the time a teacher knows the answer; they know what is coming. But with ROVs you almost feel like an art teacher. You will see something happen and think,

‘Wow, I did not see that coming. You guys came up with something that I never even thought of.’

Will believed the level of engagement demonstrated by students participating in ROVs was amazing. Will claimed, “I am constantly seeing things that I have never seen before.” He has “students wanting to come to school when they are sick,” and kids who were in trouble with recess issues hastily accepting consequences so they could “be in the classroom.” Will noticed, “ROVs allow kids that don’t generally get accolades to get some.”

Will’s fellow fourth-grade teachers saw the success that he and his students were creating and they were interested in expanding the ROV experience beyond Will’s classroom. Thus, the following year the entire fourth-grade student body at Legacy Elementary participated with ROVs. The fourth-grade teachers developed thematic instruction focused on ROVs. In addition to ROV assembly, teachers taught science, social studies, and language arts lessons based on ROVs. This thematic instruction was a highlight for staff and students alike. As these students became fifth-graders, another opportunity arose.

Eddy & Marcia’s ROV Club

Two more Legacy teachers, Eddy Scintilla and Marcia Ball, decided to get involved with ROVs. Using the Marine Advanced Technology Education (MATE) ROV contest model, Eddy and Marcia created the Legacy Elementary ROV club. Eddy taught the third-grade class at Legacy and Marcia the fifth. Both heard about the fourth-grade using ROVs, but neither was involved with ROVs.

Eddy was in his third year of teaching third-grade at Legacy Elementary School. He was hired at Legacy upon graduation from Northern Michigan University but grew up not more than 30 miles from the Springfield School District; thus, teaching at Legacy meant that Eddy was almost “back home.” In addition to teaching, Eddy has also been a middle school basketball coach since he was hired at Springfield, and the athletic director considered him to be an asset to the program.

Marcia has taught in the Springfield school system for almost 30 years. She graduated from college in the “late 70s, and there weren't many teaching jobs.” She was a substitute teacher and spent an eight-year stint working at Michigan State University’s veterinary science library. She went back to college and obtained an elementary certification, where upon she found employment at Springfield Public Schools. She is the only teacher in Springfield who has instructed at every elementary school in the district.

The Legacy principal was excited about the progress being made with the ROV unit in the fourth-grade. When he heard about the MATE Scout competition, he was interested in forming a fifth-grade team at Legacy. He approached Eddy and Marcia about their willingness to lead the team. They both expressed interest and, although Will Jackson and the rest of the fourth-grade teachers were willing to provide help, Eddy and Marcia both shared with the principal their desire for more specialized training. Fortunately there was a training session specifically designed for people new to ROVs and, in particular to coaches who desire to compete in MATE’s Great Lakes Regional ROV Contest. Of course, the training was four hours away and required driving through what is known as one of Michigan’s “lake effect” snowstorms.

Rebekah & NOAA

Rebekah Waves is the Director of Education at the National Oceanic & Atmospheric Administration’s (NOAA) marine sanctuary in Tawas Bay, Michigan. As the new Director of

Education, Rebekah assumed the responsibility of coordinating the Marine Advanced Technology Education (MATE) Great Lakes Regional ROV Contest. She also provided training for teachers and coaches involved with ROVS.

Rebekah feels the hands-on workshops are important because, “Many of the teachers that I have spoken to are a little intimidated.” As a result, her institution is “trying to do more of a baby step approach” in getting teachers to engage in ROVs. Working in conjunction with the Marine Advanced Technology Education (MATE) center, teacher training and support is offered that culminates in a student ROV competition. The training process is shown in Figure 3.

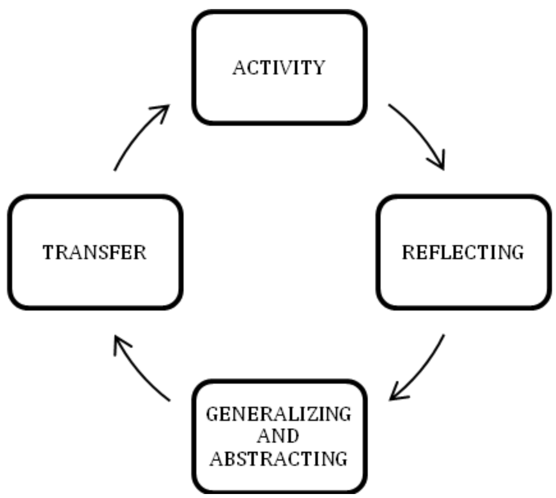

Figure 3. Experiential learning cycle.

Rebekah and her staff followed the experiential education learning cycle as they implemented the Beginner ROV Workshop. The workshop began with the *activity* of building the ROVs. Eddy, Marcia, and the other participants were guided through the construction of the ROV frame and tether basics. As groups had the opportunity to experience what students would feel and do, they were brought back together to *reflect* upon the activity. They discussed success and struggles that were experienced. Rebekah then moved the group into the *generalizing and abstracting* section of the cycle, as the class talked about how to build ROVs within the classroom and as after school projects. The level of participation in the discussion/reflection section after the activity was much higher than the initial discussion before the activity. Rebekah then had the group *transfer* skills and knowledge gained from the last three steps in the cycle and started the cycle over again as the groups then worked on the activity of adding thrusters, control boxes, and cameras. This cycle repeated itself over and over again throughout the course of the workshop. Both Marcia and Eddy commented that it was one of the best professional developments that they ever attended.

MATE Competition Classes

The Great Lakes Regional ROV Contest is one of 21 regional ROV contests that take place throughout North America, Europe, and Asia. Student teams from elementary through college compete in an underwater mission. There are three levels of competition: Scout, Ranger, and Explorer. Waves explained that the MATE center "started out ten years ago really trying to focus on the community college level but soon realized they were losing students at the middle school level." The MATE center changed their focus and created ROV competitions for the middle and high school levels. This became the Ranger class, where Rebekah stated that immense growth has taken place. This is now the largest of the three classes.

The Explorer class is still aimed at the collegiate level but now attracts teams from high schools with robotics programs "that have a chance to put in a lot of hours." Some of the high school teams are placing and winning within the Explorer class. The Scout class was created in response to feedback from "some of the younger students or mentors that had younger teens." Some of the younger, inexperienced students were very nervous "competing against high school robotics classes." The Scout class still has "the same kind of mission, but they scaled back a little bit. They don't have as many things they have to do so it's less pressure."

Winners of the Ranger and Explorer regional contests compete at the International competition. The competitions highlight technical skills and help students to develop the ability to problem-solve, think critically, and work as part of a team. MATE also brings employers, professionals, and researchers to the competitions. Students have an opportunity to interact with people in the marine industry and are exposed to marine- related opportunities and the pathways to those careers (Marine Advanced Technology Education (MATE) Center, 2011).

Springfield Scouts

After the MATE training Eddy and Marcia felt more confident in their knowledge of ROVs. They also had a specific goal, to take a competitive team to the regional contest in April. Their next step was to create a team. Eddy and Marcia decided that they would target Legacy fifth-grade students for the club. Due to both student and adult after-school commitments, it was decided that the Scout group would meet an hour before school two days a week. Eddy and Marcia felt that it would be best if they presented the concept to each of the fifth-grade homerooms. Through some creative scheduling, Eddy and Marcia presented the idea to the four homerooms of the fifth-grade students at Legacy Elementary.

They anticipated each class presentation would take about five minutes to present the information; the actual time was three times longer per class. Students were excited to have the free opportunity and asked Eddy and Marcia questions for more than 15 minutes per session. Students were excited to see Mr. Scintilla, one of their previous teachers. They were enthusiastic to have the opportunity to be further involved with ROVs. This was the first time that an elementary program at Springfield was given the opportunity to travel across the state for a competition. Students were warned that the practices would take place before school. Apparently the thought of arriving to school two hours early each week did not faze the students, as Marcia ran out of permission slips before they were halfway through the grade level. In a week's time 35% of the fifth-grade students successfully completed and returned their applications to be members of the Scout ROV group at Legacy.

Limited by supplies, space, and adult supervision, Eddy and Marcia had to make some tough decisions about whom to invite to participate. Rebekah and Will suggested that the target group size per team was three. This size allowed each of the students to have an active role in each of the building, testing, and utilizing phases. Three students per group required students to compromise and contribute; they cannot get "lost in the crowd." They had enough materials for eight teams.

Twenty-six students were invited to join the club. Fourteen of the students met the federal criteria for being at-risk of not graduating from high school. The group was expanded from 24 to 26 because it was unknown whether initial student interest would wane leaving a gap to fill. Two days after the application deadline, Eddy and Marcia announced the members of the Legacy ROV club.

The club commandeered the empty classroom previously used by the fourth-graders when they built their ROVs. This room allowed a neutral site for students to build, test, and store their ROVs. Eddy and Marcia laid out the basic format for the team on the first day the club met. Students were expected to actively participate in their team. They were expected to be at the morning practices. If they won the local contest, they had to commit to traveling to Tawas Bay for the regional contest. All of this information was in the application, so it was not a surprise when all of the selected students stayed in the room. What did come as a surprise were the rovers. The rover position was created as a failsafe; two rover students would not be on a specific three-person team. Instead they would support all eight teams and the two coaches. If one of the twenty-four students on a team quit or was removed from the club, the rover would take their position. The rovers were guaranteed to go to the Tawas Bay contest.

According to JT Fabo, who volunteered to be a rover, the guaranteed trip to Tawas Bay was the deal-maker for him. He described the other students staring slack-jawed at him when Mrs. Ball announced that the rovers would automatically go to the Tawas Bay competition. JT stated that it was "awesome" to be a rover. He enjoyed helping each of the groups on their ROVs. He was especially proud of running the power tools and drilling buoyancy holes for the different groups.

As the weeks went by and nobody quit or was removed from the club, the rover role changed. Instead of being "on-deck" to take somebody's place, JT and his partner, Scott McDonald, carved out a niche where they became part of a crucial support team. Even though the 24 students were engaged and well behaved, it still took a lot of management for Eddy and Marcia to meet their needs.

JT's grandfather, Matt Fabo, a retired project manager from General Motors, is quite involved with JT's life. He pushed JT to join the ROV club, brought JT to the morning practices and stayed around to help. Mr. Fabo became a perfect addition to the group. He was soft spoken and even keeled; he encouraged the students to find solutions through guiding questions and observations. Eddy and Marcia knew that if Matt were assigned a task it would be completed. He was not only attended each of the school practices, but also went to the pools. While at the pools, he volunteered to be in the water and reset each of the obstacles between teams. He also helped troubleshoot the robots from the water. This became another point of pride for JT, as he was the only student that "got to go in the water." He helped his grandfather set up the course, "the coral, and everything." He felt privileged because, "Mr. Scintilla would tell me where to set them up and how. Everyone was jealous." Both JT and Scott, the second rover, would be classified as at-risk students; however, they demonstrated a commitment to the club that exceeded expectations and shattered stereotypes.

In addition to JT and Scott, who chose to be rovers, the rest of the students also chose their own group members. It appeared that groups were chosen mainly based on existing friendships. Seven of the eight groups were single-gender groups. Each of the students interviewed mentioned that they appreciated being able to pick their group.

After the groups were chosen, Eddy and Marcia explained to the students that they needed to create an ROV that was capable of completing the specific tasks as established by MATE. As fourth-graders, the students' primary task was to create an ROV that could be maneuvered to go a specific distance in the least amount of time. Now, as a Scout team participating in a MATE competition, an entire thematic scenario was bestowed upon them.

Diving into History: The Role of ROVs in Exploring WWII Shipwrecks

Diving into History: The Role of ROVs in Exploring WWII Shipwrecks was established by MATE as the theme for their 2012 international completion. The MATE Center asked students to imagine themselves as entrepreneurs who are responding to a need.

In this case, the entrepreneurs were asked to “create a company that specializes in solutions to real-world marine technology problems” (Marine Advanced Technical Education, 2011).

The MATE center posed as a client that issued a *request for proposal* (RFP). The MATE Center’s RFP was for ROV companies to clear debris from the WWII shipwreck *SS Gardner,* and then to remove hazardous fuel oil. Following the MATE model, each of the Legacy groups was informed that there would be a *Springfield Showcase* to highlight the response of their team or company’s response to the MATE Center’s RFP. The Showcase would consist of two major components of evaluation: the engineering presentation and the mission.

The engineering presentation provided technical information to a panel of professionals. Each team was required to explain to the panel how they built their ROV and why they made design and construction decisions. Additionally they were expected to possess the technical knowledge to answer specific physical science and mathematical questions. Besides science and math, teams were also expected to answer social science questions regarding team dynamics, decision-making processes, and economics. The engineering presentation was worth 50 points (Marine Advanced Technology Education Center, 2011). In addition to the engineering presentation, companies were also expected to create a poster display for the competition. The intent of the display was to be a form of publicity that summarized each company’s existence. The 30-point poster was to include the company name and school name, an abstract, staff information, ROV design, competition theme, company evaluation, and acknowledgements.

The mission comprised two tasks. The first task was to inflate lift bags to remove debris from the ship’s hull. The scenario involved companies clearing three pieces of the ship's mast that fell onto the hull. The individual pieces were too heavy for the ROV to lift with its thrusters. Thus, the companies used lift bags on each of the three mast pieces. The task was to fill the lift bags with air to raise the mast pieces to the surface.

The second task was to transplant endangered coral and collect samples of oil from the shipwreck. Each company was required to collect samples of the fuel oil that remained on board the SS Gardner. Similar to the first task, there is a caveat: each company must clear the hull of organisms that have grown over it. One species growing on the hull is an endangered form of coral. Because the species is endangered, it must be transplanted. The process to comply included the following tasks in order: 1) teams must remove the endangered coral from the hull, 2) transplant the coral to a designated area, and 3) collect and return oil samples to the surface.

Just as Rebekah Waves had the authority to modify some of the MATE Center's requirements for the regional competition, Eddy and Marcia decided to exercise their authority by modifying some of the requirements for the Springfield Showcase. Due to time constraints, companies were not required to complete the poster requirement or the lift bag mission for the Springfield Showcase. However, the winning company of the Showcase was expected to complete the poster and the entire mission for the Great Lakes Regional competition.

The Race to the Showcase

Most ROV teams have access to their school pool. However, Springfield Public Schools is without a natatorium. When Will brought the ROV program to Legacy, he tucked away a soft-sided children's pool in the school's boiler room. This pool became the practice area for his classroom. When the program expanded to include the entire fourth-grade, he worked out a deal with Tractor Supply Company to secure two livestock watering troughs. The aluminum troughs became the home for the ROV program at SCS.

An unintentional benefit to the latest round of budget cuts at SCS was an empty classroom in the same hall as Marcia's classroom, which became the practice ground for the Scout team. Because the classroom did not serve 30 students during the day, the Scouts were also able to store their ROVs and the water troughs in that location.

The troughs allowed students to test buoyancy and thrust. Due to depth and length of the troughs, the students were limited in opportunities to practice not only piloting skills, but also all of the ancillary skills necessary for completing the missions. Rebekah Waves stated that "pool time is key" to ROV success. Throughout the years Rebekah noticed teams "that don't do as well, it's all because they don't have pool access and some practice time."

Eddy and Marcia knew that they needed to find a pool for the Scout students. Options were limited due to geography and finances; however, they reached out to outlying communities to explore options. They contacted entities they knew had pools: school districts, non-profit organizations such as the YMCA, rehabilitation centers, and hotels. To their surprise, they found a school and a hotel located within the suburb of West Arbor Hills, whose officials were excited to work with them.

The school district of West Arbor Hills is located in a higher socio-economic community than Springfield, and historically there had not been good relationships between the two school districts. However, the pool supervisor at West Arbor Hills was willing to host the Showcase and one practice session for only the cost of the lifeguard instead of their normal rate for use of the pool. The Comfort Inn in West Arbor Hills was even more generous. The manager stated, “At 7:30 in the morning, the only person that even notices the pool is the maintenance man.” He allowed the team free access to the pool.

With access to a pool, the logistics of travel and scheduling became the next hurdle to overcome. First, the team tackled the schedule; with only 14 practice dates, it was important to use the time wisely. They planned on staying at Legacy during February. During March they scheduled three trips to the Comfort Inn pool and one to the school pool. The idea was that the pool time would allow students to practice the missions exactly as they would be at the Showcase and the Regional competitions. Furthermore, the pool practice would allow the opportunity for teams to improve their communication skills and individual roles within the teams. Teams could then go back to Springfield and make modifications based on the data from the pool tests.

More parents than needed signed up to carpool to West Arbor Hills. Students were expected to arrive at Legacy at 7:00 a.m. to be to the pool at 7:30. Except for a couple of driving direction mishaps, the pool practices went off without a hitch. Attendance rates were always close to 100%. Eddy stated that the few times a student was unable to attend, he had parents calling in to excuse and make sure that the team was aware. Eddy and Marcia both stated that the attendance rate and responsibility when absent was above that of their individual classrooms.

Time continued to be in high demand and short supply. Students and coaches all commented that the practice sessions seemed as if they ended five minutes after they began. Each group responded to the pressures in different ways. Some groups, such as the Invasion of ROVs, would get frustrated but then rally to solve the problem and move forward. Other groups, like The Ninjas, would ask for help, but then not want help; they would then implode. The imploded groups would blame each other for failures, fight with each other, and even walk away from the group. However, as it came down to the Showcase, all of the groups felt they could win.

Springfield Showcase

Invitations to be a judge on the presentation panel were sent to the fourth-grade teachers involved with ROVs the previous year. The Scouts current fifth-grade teachers and their art, music, and gym teachers were also asked to serve on the panel, as was John Jameson the high school robotics teacher. The Parent Teacher Organization’s executive board, Legacy’s principal, and Springfield Public Schools’ curriculum director, and superintendent were also invited. The response was overwhelmingly positive. Ultimately, the panel comprised two teachers, a PTO parent, and two administrators. The pool missions were judged by the Legacy principal and the middle school principal.

Students appeared anxious and excited as they prepared to present their ROV and experience to the panel; nervous laughter drifted through the hallways. Students were seen whispering to each other and quizzing each other. Many of the students were seen pacing back and forth in front of the presentation classroom. Some of the students dressed as for school picture day.

The panelists posed open-ended questions to the groups. When one of the team members would try to dominate the presentation, a panelist quickly posed questions to one of the other team members. Panel members believed that student responses were expressed with confidence and thoughtfulness. Panelists expressed their surprise in the confidence level of the students. Of the possible 50 points awarded for responses, the lowest score was 26, the highest 43. The median and mean scores were both 35.

The mission portion of the Showcase took place at West Arbor Hills' pool. The rovers, led by Mr. Fabo, set up two courses in the deep end of the pool for the students to complete their missions. In the shallow part of the pool, students could practice and make any last minute adjustments to their ROV.

After a practice time, each team was alerted they were *on deck*; this meant they needed to bring their robot to the side of the pool and be ready to compete as soon as the previous team completed. Teams had a maximum of ten minutes to complete their missions. For scoring, the mission portion was worth a total of 60 points, with 30 points for each of two sections, the coral transplant and the collection of oil samples. Teams had to finish the coral transplants before they could collect the oil samples.

In addition to the possibility of earning points, teams could also have minutes added to their score for penalties. For example, if the team needed the assistance of a diver (Mr. Fabo and his rovers) a minute was added to the team's time. If a team member pulled on the ROV tether, five minutes were added to the allotted time. If a team blew a fuse, a minute was added to their time; fuses blown three times disqualified the team from the event and earned zero points. The points and penalties for the Showcase were the same as the MATE Center's regional and international competitions.

Upon completion of the missions, the judges tallied the scores. Half of the teams tied with the highest score of 30 points. However, the other half scored no higher than 12 points with one team scoring no points and another team scoring negative points. The median score was 21 and the mean score was 17.

Final Showcase scores were calculated by adding the points earned from both the engineering presentation and the pool mission. Teams were then ranked from the lowest to highest. The median score for the Springfield Showcase was 53.5, and the mean score was 52 points. The Ninjas scored the lowest with 26 total points and the Invasion of the ROVs scored highest with 73 points.

Invasion of the ROVs

As the winners of the Springfield Showcase, the three-girl team, Invasion of the ROVs qualified to represent Legacy at the Great Lakes Regional Competition. Marcia stated that she was not surprised they won because at every practice, "They would come in and do what they had to do; they were always the first ones done, every week, every session. They would be done before the rest of the group, every step of the way." The girls in this group would not be considered at-risk of not graduating from high school. Each of the girls came from supportive homes and was an honor roll student involved in other extra-curricular activities. As they prepared for the regional Scout competition, their team, family, and coaches were excited about the potential outcome.

Practice sessions continued at Legacy and the Comfort Inn, with parents transporting. Watching the girls practice and compete, it was clear that each of the girls assumed specific responsibilities within their team. They were able to recognize the importance of each role and improved their skills within the role. For example, Holly was responsible for holding the tether of the robot. She refined where she stood in relationship to the pool and the driver, and she also improved the rate of release and tension on the tether. When the team was at Legacy, they focused on improving the engineering presentation and creating a poster presentation. Days before the competition, a set of parents donated matching team tee shirts to the group. The girls wore the shirts around the school with obvious self-satisfaction. With a pioneering sense of pride and confidence, the Invasion of the ROVs headed out to Tawas.

Great Lakes Regional Competition

Although not a convoy, five cars left Springfield and headed north to Tawas Bay. The girls and parents of the Invasion of the ROVs and Marcia and her husband decided to make a weekend out of the event. The Invasion group had big plans for not only the competition, but also for hotel pool time and shopping. Eddy and the rovers spent a night in Tawas and headed back to Springfield after the competition.

Rebekah Waves and her staff from NOAA were well prepared and excited to be hosting the event at the East Tawas High School. The library housed the engineering presentations. The gymnasium was divided into two sections; the first was an area to display the poster presentations, the second a staging area for the teams. The missions were conducted in the pool, which was adjacent to the gym. The hallway in front of the gym served as promotional areas for related research, education, and commerce groups. Additionally, a lunch for all participants was served in the cafeteria.

The Legacy Scout team met in the gymnasium. The sheer amount of occupied square space, as well as the number of people in attendance for the event, was more than the team anticipated. The girls set up their display in the presentation section of the gym and unloaded their materials at the staging section. Last minute mission and presentation strategies were discussed between the team and the coaches.

Teams were informed that they could not have any adults in the mission area, but they could have up to six students. This meant the rovers would assist in the mission. This news came as a welcome relief to the team because they were struggling with a particular section of the mission.

The section of the mission that required the air bags to be filled turned out to be a larger challenge than originally anticipated. During practice, the girls became fatigued using the air pump in addition to their normal responsibilities. The rovers were excited to be able to be in the competition and have a specific responsibility. Eddy stated that bringing in the rovers to run the air pump, being an extra set of eyes in the pool, and a source of encouragement alongside the pool, was “good news for the entire team.”

The team went poolside and took their positions. It was time to begin. The first task was to transport an air line to three different lift bags, then to fill the lift bags with air allowing the bags to surface. This task was worth 20 points per bag. With a refined sense of communication, the team’s ROV expertly glided to the first lift bag. The rovers were instructed to start pumping. The rovers exhibited an extraordinary amount of power and precision as they responded to the commands of when and how much air to pump. Within two minutes the first lift bag was floating on the surface. They continued this pattern through the next two lift bags. Without blowing a fuse or pulling on the tether, the Invasion of the ROVs finished the task in eight minutes and 31seconds. They received an additional time bonus point giving them a total of 61 points for the first task.

The second task of the mission was the same as in the Springfield Showcase, the coral transplant and collection of the oil samples. The timer ticked down from ten minutes and the team headed straight for the coral. They removed and transported two of the corals when an unanticipated accident occurred. The ROV was suddenly dead in the water. The girls looked around to find the source of the power loss and noticed that the connection to the battery was severed.

In the excitement of the moment, one of the rovers became tangled in the power cord and disconnected the ROV from the power source. Kristine, the pilot of the team, saw the problem and immediately jumped to the battery pack and reconnected the power. The ROV was back in business and heading to remove the third coral. Anticipation and excitement grew as coaches, family members, and spectators watched the team and the clock. The team was straining for better views of the ROV when again, the rover tripped on the power cord. A groan was heard from the spectators and Kristine launched into action. She commanded the two rovers to hold the wires to the power sources.

Kristine noticed her controls were producing a reversed effect but did not fully grasp what was taking place. In hindsight, the team realized that the rovers were holding the wires to the opposite poles of the battery resulting in the controls to function opposite to their design. The Invasion of the ROVs ended up successfully transporting four of the five corals. However, they ran out of time while trying to collect the oil samples. As a result their grand total for the mission was 24 points.

The girls and the rovers all agreed that the event was a blur and that the mission seemed to be over in a fraction of the allotted time. However, they were excited to compete and happy with how they handled themselves during the tasks. They had two hours to reflect on their performance, eat lunch, and prepare for the engineering presentation.

The engineering presentation was very similar to the Springfield Showcase. Again the team was questioned by a panel, perhaps more expert than the Showcase, but based on a rubric with the same categories as the Showcase. The girls erred on a few technical details that they had also scored lower on during the Showcase but overall, their stories of lessons learned and understanding of original work was evident, as indicated by the judges score sheets. They received 36 points for the engineering presentation

Amid the parents, coaches, and supporters offering accolades to Invasion of the ROVs stood their former fourth-grade teacher, Will Jackson. Will was at the event not only to lend support to the Legacy Scout group, but also as the chaperone for the high school Ranger group. The Ranger group present at the competition was a substitute team for one that was originally slated to compete but prohibited to attend the competition. The group present appeared to be tired and somewhat unenthused, perhaps because running an ROV in a pool simulation felt like a step down from their last mission, exploring downed World War II aircrafts in the South Pacific.

Springfield High School

In addition to being a teacher, Will Jackson was also a basketball coach. As a former Big Ten player, Will had the skill and passion to be an outstanding coach. Among his many basketball players was the daughter of Springfield High School's robotics teacher, John Jameson. John "shagged balls" during basketball practice for Will. During one of the practices Will mentioned the ROV project to John. He asked if John's students would be willing to help create the control boxes for the ROVs. John was willing to help and also intrigued about the idea of underwater remotely operated vehicles.

John is a Springfield Public Schools alumnus. He decided to become a teacher after retiring from the United States Navy. With a business degree and teacher certification from Eastern Michigan University, John was hired to teach accounting and business classes at Springfield.

To make business principles more meaningful to his students, John's students ran a school store, which offered clothing, school supplies, and spirit gear. However, their main source of profit was from snack food; candy, chips, and soda were in high demand and provided high returns. The store was so successful that it became a source of revenue, and the high school began to depend on the revenue for funding projects that were not in the district budget. For example, an electronic marquee in front of the high school announces upcoming events. The entire project was funded from profits from the school store and the display can be updated from within the high school.

In addition to the business classes, John also taught a robotics class. They built robots using LEGO VEX units. Students not only assembled the robots but also program the robots to perform specific tasks or respond in a specific manner. It was common to see students working with the robots not only in the classroom but also in the hallway and even in the cafeteria.

John always looked for ways to enhance the student experience within his classroom. In addition to the LEGO VEX, he expanded into LEGO NXT, which allowed students to experience a deeper level of programming and building. In addition to the classroom involvement, John presented the opportunity for his students to participate in a competition at a much larger venue.

Lawrence Technological University (LTU) is located in metro Detroit and has historic ties to the Motor City's automotive industry. In 2000, Lawrence Tech created Robofest, or Robot Festival, as "an open contest in which the participants can show off their robots while learning problem-solving techniques, team work, mathematics, mechanics, physics, creativity, logic, and computer programming." (Lawrence Technological University, 2000). During the first year, 109 students participated at a single site in the competition. In just more than a decade, Robofest had 2,420 students participating in 29 sites. Presently, "Robofest is an annual autonomous robotics competition designed to promote and support STEM (Science, Engineering, Technology and Math) and Computer Science for students in grades 5-12 and college students."

According to John, his students were excited to expand from the classroom to the cafeteria and on to a much larger venue. They did well in the qualifying event, which allowed them to compete in the championship. The regional event took place on the campus of Lawrence Tech and the championship event was held in downtown Detroit at the General Motors headquarters. John saw how well the students were responding to these events, and when he heard about the ROV event that was taking place, he threw down the challenge to his class to participate in the MATE Center's competitions.

Transition

Similar to the elementary students at Legacy, John's students practiced in a feed trough and made an occasional voyage to the community pool in West Arbor Hills. The students practiced not only during their class time, but also during their lunch break and after school. John stated that he never had to remind or push the students to practice; they came to him looking for more time. These experiences also functioned as a recruitment tool for John and his program, whose classes were often viewed as a place to fill a hole in a student's schedule or provide a support class for students who struggled in a traditional core class. One such class became the Ranger ROV team.

John enrolled his class in the Ranger division of the MATE Center's competition. He showed a few videos to the students about their mission and instructed them to apply skills learned from the robotics class to form their first underwater vehicle. A primary difference between the robots is the control. The LEGO robots were programmed and then autonomously completed the mission or competition, whereas a pilot on the surface controlled the ROV.

MATE Center Competitions

The Ranger team comprised four high school boys, two juniors and two seniors. Senior Danny Tanner stated that it was a great group that worked well together because "we were all close friends." Danny stated the quartet would "divide the tasks evenly to get the job done" and that part of their success was because it was always "a team effort." Half of the boys possessed at least two of the characteristics of being students at-risk of not graduating from high school. Furthermore, two of the students were receiving additional academic support from special education teachers. However, their work ethic and problem-solving skills propelled them through a series of trial and error attempts that resulted in a confident team.

The first year that John led his students to the Great Lakes Regional competition in Tawas Bay, they were not sure what to expect. They knew the competition was open to teams from the Midwest including colleges and universities. Many of the teams would have financial and technical backing from large manufacturing or engineering interests.

The mission the first year was "to deploy instruments, take sensor readings, plot data, and collect samples of geologic features and organisms that inhabit the flanks of a simulated underwater volcano" (Marine Advanced Technical Education, 2011). Because the clock started as soon as the team hit the deck, each of the boys had a specific responsibility to perform before and during the mission. They practiced their mission, polished their presentations, put the finishing touches on their poster display, and headed north to Lake Huron.

They competed against 15 teams at the regional event. Many of the other schools came from much more affluent districts with access to water much deeper than the feed troughs. However, the Springfield team outscored the other teams and secured a winning spot at the competition. They had a decision to make.

International Competition

As both Robofest and MATE winners, the Springfield team needed to decide where to go next. The international competition for Robofest was to take place in Detroit, Michigan. The international competition for MATE was to take place in Hilo, Hawaii. Although Detroit was closer and cheaper, the team was excited about the prospect of competing in Hawaii.

Funding a trip to Hawaii was a challenge. When John Jameson and his students ran the school store they produced revenue. However, the robotics classes were exclusively expenditures. John was not sure if he could get permission from the school board to go to Hawaii, but he knew that he would not get funding from them. The team presented their plan to the school board and did a good job persuading the members of the educational benefits of attending such a competition. Permission was granted by a 7-0 vote. As anticipated, the school board stipulated that the trip was to be at “no additional cost to the district.”

John needed to raise $8,000 to get his students to Hawaii. The sheer novelty of a landlocked school going to a Pacific island to compete using an underwater robot brought in a surprising amount of individual donations. People stopped by John’s classroom and give him $20; they dropped into the superintendent’s office and give a check for $50. Grants and donations from businesses were also forthcoming. Within ten weeks, the team boarded a plane at Detroit Metropolitan Airport and headed west to the Pacific. Being a regional winner and going to an international competition in Hawaii is big news in most environments; in Springfield, it was historic. An academic-related endeavor from Springfield schools had never before competed in an international event.

Success Breeds Success

The year following the Hawaiian competition, the ROV class doubled in size. However, because all of the students from the Hawaii team graduated, the program was essentially starting over. In addition to the increase in the size of the class, the new crop of students also brought a new student demographic into the program. Fifty percent of the group was still considered at-risk of not graduating from high school. There were still students on individualized education plans, as outlined by special education laws, but in response to the success of the ROV program, students who traditionally filled their schedule with advanced placement (AP) or college preparatory classes enrolled in the robotics class. To meet this new demand, the ROV course was renamed "advanced underwater robotics." John Jameson said it looked better on transcripts than "independent study."

Two advanced placement (AP) boys, Tyrone Montoya and Roger Russell, brought a passion for engineering and a friendly demeanor to the retooled team. When discussing the dynamics within the team, Sam Emerson, an at-risk student from the team stated, "everyone was sort of aquaintances (sic) with Tyrone and Roger because they were just friendly with everybody." Jameson stated that the two were driven. They were the type of students that from elementary school knew "where they were going to college and what type of engineer they were going to be."

The high school team again won the regional MATE contest in Tawas Bay. This time, the team would travel to Texas to attend the international competition. Before the students left for Texas, they again presented to the Springfield Public Schools Board of Education. Like Will Jackson, several of the board members and building principals were pleasantly surprised to see students who struggled in school appear to be passionate, knowledgeable, and engaged in an academic endeavor. The opportunity to appear before the school officials allowed the team to practice and improve their engineering presentation.

From Michigan Cornfields to Pacific Paradise

A reporter from a regional, weekly newspaper attended the Springfield Board of Education meeting that featured the Texas ROV team. She took a picture of the group and composed an article about the ROV program. Although circulation of the weekly newspaper was limited, that particular issue ended up on the top of a mail pile belonging to a pilot from West Arbor Hills.

The pilot is a member of the P-Man Project, a non-profit organization that works with the United States armed forces to identify planes and soldiers who were declared "Missing In Action" during World War II. The pilot and his group had recently returned from an exploration to the central tropical Pacific island nation of Kiribati. During that trip, the P-Man Project concluded they had exhausted the resources of the exploration divers. The United States Navy suggested the P-Man group look into acquiring an ROV. The pilot read the article about Springfield's ROV program and reached out to John Jameson to see if his students would be interested in building the recovery group a ROV.

Dewey (1902) was concerned that the child's experiences and the school's curriculum were set against each other. In his words, "The material is not translated into life-terms, but is directly offered as a substitute for, or an external annex to, the child's present life" (p. 24). The recovery group's proposition gave the students the opportunity to experience the translation of the school material to the wider life-terms of working on a commissioned project. It was a further example of serendipity to realize that the MATE theme for the same year was World War II recovery. The Springfield students were no longer creating an ROV for a competition, but for an authentic, present life mission.

The shift in student demographics was already taking place within the "advanced underwater robotics" class at Springfield Public Schools. There were fewer at-risk students enrolled in the class. When Jameson made the mission to the Republic of Kiribati the primary focus of the class, the demographics shift eliminated at-risk students from the class roster.

The students in the reconfigured class would not be considered as at risk of not graduating from high school; just the opposite was true. None of the students were ethnic or cultural minorities, nor were they lower on the scale of socioeconomic status. None of students had a discipline record in their files, nor probationary status with the court system. None of the students had attendance issues. Based on their transcripts, these students would not be consisted academically disadvantaged. One family of divorced parents was the only at-risk factor identified for the ROV class as it evolved. Even in that case, both parents continued to live locally and be involved with their children's education. From elementary school on, these students were on track to graduate within the top quarter of their class. The biggest concern to this team would be a risk of graduating cum laude as opposed to summa cum laude.

The adventure of the Springfield ROV group paired with the WWII recovery team is an example of experiential education. However, because that team does not include at-risk students, it is outside of the scope of this research. This chapter served as a background to demonstrate how project-based learning can start with an idea from a small group of people and expand across grade levels and the status quo. The example was selected in part because it was unique. The culture of Springfield Schools is not one tied to the maritime industries or progressive education. Although this research is unique to Springfield, their demographics are similar to many other school districts throughout Michigan and the Midwestern United States.

Chapter Five: Findings

I spent significant time observing practices, interviewing participants, and examining artifacts. I used Creswell’s (1998) verification procedures of prolonged engagement and persistent observation, triangulation, peer review and debriefing, negative case analysis, and clarification of researcher bias, to increase the validity of my findings.

Although the students and adults met and worked in traditional classrooms, the rooms looked and felt much different than a traditional environment. The physical structure of the room was based on the function of the activities and not for attending to an individual in the front of the room. The students often worked in many different parts of the classroom and, of course, feed troughs were focal points in the classroom.

As I observed and analyzed, I pondered what made this learning environment different than other learning environments. It was unique for the students to be building underwater vehicles, but something else was also taking place. The classes and clubs were not homogeneous in terms of gender, socio-economic status, race, or academic ability; however, the at-risk students appeared to act differently in this setting. They were active participants in the classroom; they were not marginalized or given alternative assignments; they were being held to the same expectations as the advanced students.

I read and re-read the transcripts and began to identify, name, categorize, and describe what was taking place. This *open coding* led me to identify prevalent themes that appeared to be taking place at both the elementary and secondary levels. The themes seemed to fall into two major interrelated categories: implementation and impact.

Implementation Themes

I identified the themes of time, teamwork, communication, and problem-solving as themes that fell into the category of implementation. These themes were largely influenced by the adults. For example, the adults set the length of time for the semester, unit, practice, and meetings. Adults also set the parameters for group selection, which affected the team composition and teamwork. The adults also structured an environment that had some bearing on communication and problem-solving. I did not get the impression that the adults were fully aware of how much influence they could have over the environment and how much the implementation impacted the students.

Scarcity of time. Time is a concept used to categorize and measure events. Many facets of time have a direct influence on adults and students involved with ROVs. This section will focus on the scarcity of time, the consumption of time, and time management. There is a finite amount of time in the school day and school calendar; there are many demands on the teacher for that time, the teacher is trying to manage many variables, and many teachers may be concerned about introducing ROVs into the curriculum.

When Will Jackson first brought the ROV concept to his peers, he noticed there were a lot of worries about "How am I going to fit this in? How are we going to even manage it?" Teachers in Springfield were not alone feeling demands of limited time. Rebekah Waves also spent much of her time recruiting, training, and supporting teachers involved with ROVs. She noticed that many teachers felt that, "It's overwhelming." "They only have so much time."

The scarcity of time was not limited to adults. Cal Naughton admitted that his group took some shortcuts when it came to wiring the controls. "We never really got time to finish it. They were going to dry these tubes that tighten right on when the heat hits it. But, we never got done with it, so we just covered it with tape instead." When asked if the shortcut worked, he replied, "It never really worked out because it kept coming back out."

Marcia also admitted to allowing some reverse wiring to stand. She said, "They would have to open it up. We felt like there was not enough time to open it up and redo it." She was quick to add, "But really, they should have. Because they knew it was wrong, but we did not take the time. It would have been good to have time for them to redo it."

Adults and students alike discussed the time needed to develop skills and knowledge relevant to ROVs. Marcia and Eddy attended a day-long professional development session aimed at new ROV coaches. Marcia stated, "I think the PD was definitely helpful but I was always looking for ways to improve my skills." She went on to say, "I feel I can learn anything. I think I could have learned those things had I have known ahead of time or had enough time to work it out. I didn't have as much time as what I usually have to think about my end goal and the steps I would need to get to the end goals." In addition to the coach training time, Marcia stated that the rovers also needed training time. She said, "They needed a separate sit down time. Maybe a training session about how you help without doing or taking over." Jackson agreed that it takes time to plan. He said, "You have to sit down and collaborate. You have to show them. You cannot do it in passing." However, finding that time is an ongoing issue.

The Scout group met two days a week. When asked if it was enough time, Michael Long stated, "I felt we needed three or four days a week." In particular, he needed "a little more design time." Coach Eddy Scintilla agreed, "Having more time would help. I think if we were able to go to the pool on a similar schedule and having at least one more day in the classroom that they can spend problem-solving and learning more about the ROV."

Eddy felt much of the time was spent on building the ROVs. To improve for the future, Eddy would like to see students have “More time with their ROV to learn about the specifics of ROVs. Not just the build part, but spending more time on the circuits, more time on learning the components of the ROV and the real world connections.” He felt, “Our teams knew what the missions were but still did not understand the whole global picture as to why we are doing those missions. They knew they were getting an airbag to the top, but did not understand the leaking ship and the devastation of the oil on the ocean.” He said, “That piece was not really able to be brought in based on the time.” If he could make a change, Eddy stated, “I think that is what I would change. Not only them learning more about the ROV but the skills and time to make the connections.”

The process of planning, scheduling, or arranging when something should happen or be done is called time management. Managing time to maximize logistics and learning can be complicated and require some creative scheduling. Springfield High School manages their daily schedule by operating under a block schedule; their day is broken into four 90-minute classes. Proponents of a block schedule felt that the 90-minute sessions allowed for more depth and concentration of the content. They also felt that it allowed students to receive more work or lab time and gather more credits during a school year. Jesse Tanner felt that the block schedule, “makes the day go by a lot faster.” In particular he appreciated that it “gives you more time in that classroom.” Even at 90 minutes, Jesse suggested, “maybe extend the time for the class period.” He found “it's more hands-on so it's more time consuming.”

In addition to the class periods, students from John Jameson’s ROV class maximized their lunch period to provide more time to work on their projects. He stated, “Kids don't run out to lunch. They wait till the line goes down. They go out and grab their lunch. They come back and they program and eat at the same time at the computers." Additionally, Jameson said that he "had kids that would come in after school or before school and work."

Eddy and Marcia struggled to find the time to communicate effectively with each other. Marcia said, "We did not make much time." They talked with each other on the days they traveled to West Arbor Hills for pool practice. Eddy confirmed that they did not really talk, "other than the days of [pool time] ROV travel." He felt, "It's almost like we needed some planning time to prepare for the week." He went on to say, "The small amount of time that we did get may not have been used as efficiently as it could have."

Marcia and Eddy established a timeline for the Scout group that started after their training and ended at the MATE competition. Eddy was happy with "the success of meeting that timeline." However, "I wished we had another month to get it in." When asked suggestions for improvement, Eddy replied, "I would say to build that timeline. Maybe have some long-term goals but with short-term deadlines."

Time felt like a scarce commodity for individuals involved with the ROV project. Time was needed for planning, instruction, application, and refinement. Since there were so many demands on time, students and adults had to be creative and efficient with their use of time. Not a single adult or student involved with ROVs felt that there was too much time or that they lacked the ability to fill the given time. The use of the allotted time was influenced by the group consistency and dynamics of the team.

Immersed in teamwork. When students at Springfield Public Schools worked with ROVs, they worked in groups. Group sizes ranged from three to eight members per ROV. By default, these groups have been called teams. The design of the group format immerses the students into a team environment. Using the definition of team as *a group of people linked in* *a common purpose*, the Springfield ROV groups would be considered teams because they all had a very specific mission they were trying to accomplish. This section will explore the relationships and interactions among team members.

Adults and students commented on how well the teams got along and worked with each other. Chris Perez enthusiastically stated, “We got along really well.” When asked about what he most remembered and appreciated about his ROV experience, he answered, “I would say being with the teammates.” Roger Russell was on three different ROV teams at the high school. He stated, “They all work[ed] together really well.”

As a coach, Eddy Scintilla was pleased with the teams and reflected, “I felt like there was not a lot of bickering or certain students ruling the group.” Both Eddy and Marcia commented that, based on classroom group work, they were concerned “Kids might argue a little more, get frustrated, and give up or state that they did not want to be on this team anymore.” However, Eddy and Marcia were pleasantly surprised that this was not the case. As a volunteer, with no previous experience working with student groups, Matt Fabo observed, “They seemed to get along quite well and there was quite a spectrum in there.” Mr. Fabo went on to comment, “I never saw any conflict.”

Groups that efficiently engineered and controlled their ROV and also did best on the presentations were groups that worked with each other. Marcia commented, “There were some groups that worked very well with each other.” When asked about a key distinction, she answered, “One of the distinctions is how they came to me or Eddy about their problems. The ones that worked well together never complained about the other kids in their group.” Conversely, she noticed, “The ones that didn't, we heard ‘so-and-so is doing this so-and-so is doing that.’”

Eddy noticed that struggling groups, groups that did not perform as well or argued with each other more often, shared a characteristic–"Everyone wanted to be in charge. No one wanted to do the secondary jobs. They all wanted to drive. They all wanted to cut. They all wanted to attach something." Individually, "it was great to see" such enthusiasm, "but for that group, it wasn't working." He felt "they could not delegate" and that had an impact "as far as making the group dynamics work."

Personalities had a large impact on the group. At the high school level Sam Emerson talked about personalities, "I mean some people have the pushy personalities, so they try to push their way into what they think will be the easiest or funnest (sic) job." Sam went on to say, "Some people try to talk their way into it." Roger Russell shared a similar perspective, "I felt like I could have done the pilot, too, and Tyrone could have done it, but we let the people who really wanted to, do it."

Chip Diller was one of those people who really wanted to be a pilot. He was a member of the team that went to the international competition in Texas. Chip said, "I was able to turn it around in the trough. And that basically just made me the driver." Sam reinforced Chip's statement. "The rest of the team would go side with the person who could actually do it and that's what we needed." Chip "drove for the regionals competition;" however, as the team prepared for the international competition, personalities prevailed and "they wanted to switch drivers for some reason." To this day, Chip says, "I don't know why they wanted to switch drivers for the [inter]national competition?"

Roger could see the dynamics of the group a bit better than Chip. He observed, "some of the people who were the pilots, they felt like they were in charge of the team." When asked about a specific team captain or leader of the team, Roger replied, "We haven't really had a leader like a distinct leader of any group." Part of that may have been due to group dynamics, as Roger went on to say, "I feel the Texas team, they'd get too cocky. It was a good thing there wasn't a leader specified."

Three years into ROV work, and a high school senior, Roger Russell expressed, "This year is the first year that I've actually told people I'm the leader." As the leader, he is building redundancy into positions, "We were making sure they [all] know how to work the cameras and stuff on the robot."

Roger is the student who has been with the ROV groups in Springfield the longest. I asked Roger if he felt intimidated or taunted when he joined as a sophomore. "It was more respect than taunting because it seems I actually made a couple of friends in that class and they were seniors." He went on to say that the seniors "actually came to me for questions to make their robot better, and they wanted to be my partner in the next mission."

Eddy noticed, "As the groups played out, the groups that really had a hard time agreeing on an idea, working together, following directions–the kids I would consider at-risk, they struggled. The kids that I would not consider at-risk were the ones that were much more responsible, on-task, followed directions." Eddy said this was true "across the board." From, "even simple cleaning-up types of things" to how they "handled frustrations." This was particularly true with the groups that "were all at-risk kids," particularly, "in the behavior and responsibility piece." However, "If there was a group with an at-risk kid with two that weren't at-risk, they fit in and did an excellent job in that group." He said this was true as "both as a leader or a follower in that setting."

Friendships appeared to have an influence on the dynamics of the teams. Marcia noticed, "It seemed like the kids that knew each prior to the experience did well together."

Perhaps it was because “they already had a relationship.” As an example she cited, “The girls that ultimately went to Tawas. They knew each other and were friends from before. They did well together.”

Jacob Favre was an at-risk student who picked his team members because “I knew them for a long time, and we have been pretty good friends for a while.” He felt they would work well together because, “We could work things out.” Marcia agreed and used them as another example of students who “knew each other outside of this [and] were friends before.”

The dynamics and relationships of the group are very important. Tammy Blanchard advised potential members, “Choose the right group of people. Choose like, not your best friends, but people who you think you’re going to work well with. And just try hard.”

Michael Long suggested looking for “someone who would listen to ideas.” He said he would have liked “friends that I would know and could talk to.” Unfortunately, in his all at-risk group, “I would tell them an idea and they would not even be paying attention. They would just start building random things.” Cal Naughton cautioned, “Make sure your team is going to work good together. If you don't have a good team, it sometimes does not work out.”

Students participating in the ROV project at Springfield were immersed in a team experience. Group dynamics had a large influence on how well the teams worked together. Teams that worked well together had specific roles and a leadership structure that was based on skills or a distributed style of leadership. Teams that struggled to accomplish defined tasks were often groups that did not resolve conflict or work with each other to overcome obstacles. Social status, including at-risk status, appeared to have a large influence upon the dynamics of the group and their teamwork. Furthermore, the communication structure of teams appeared to have an impact on group interactions.

Deliberate communication. Observing the participants and listening to their stories, the theme of communication was described and identified in both overt and subtle ways. Communication is essentially an exchange of information. This is a simple definition of a concept that is far from simple. It is often a complex process involving interpretations of verbal and non-verbal cues. The interpretations can have a dramatic impact on people and organizations alike. This section will examine the theme of communication as it relates to ROV involvement.

Dr. Jack Walton, Director of Scientific and Educational Programming at the Great Lakes Research Center (GLRC), in Sheboygan, Michigan has communicated with several thousand people about ROVs. He told me, I was “just adding up recently. I broke over 10,000 people (who have) now have heard my presentations on ROVs.” He explained that Science, Technology, Engineering, and Math (STEM) learning is not limited to just the content, “What I see in all of those is not only the STEM learning but also the activities that lead to better communication, team-building, and the accomplishment [of] a specific goal.”

Further, in many environments, “they really are not getting communication skills and teamwork now.” However, he added, “these particular [ROV] classes that I've been involved in, really at least gets them to take a look at some physics, thrust, and buoyancy. As well as [the] communication and teamwork skills.”

Walton went on to provide an explanation of how creating and using ROVs is a form of communication. “I [had] an interesting experience recently with a bilingual group, which means basically probably half the students didn't speak English at all. We bring out a whole bunch of [ROV] buckets in a cart and give them a mission and then let them design their own vehicle and do the mission. What I heard from the adults and the teachers, in that particular setting, was they hadn't thought of those kids as being very smart. [However, when] they saw them be able to do all this stuff, it was a good reminder that these kids are actually [smart], they just don't speak English."

Communication between students and adults involved with ROVs often involved deliberate communication. Chip Diller shared that at each of the MATE competitions students have to be able to verbally communicate with judges. "You had to explain the process of making it. You had to explain why you were making it. It was for the oil spill, so you had to give kind of a little background story about your team and about your robot and how it works."

Building or enhancing communication skills was not only for the students, as the need for an effective communication process is important for students and adults. Eddy and Marcia both shared candid stories of how they struggled to communicate with each other. When asked about the roles of co-coaching roles, Marcia responded, "It wasn't very smooth." Eddy agreed, "The communication between Marcia and I was challenging."

Marcia did say, "Eddy and I got along okay." She felt the trouble was, "We never really talked outside of ROV [build] time." In particular, Marcia felt that objectives and guidelines of the Scout ROV club were not clearly communicated to her. "There wasn't [sic] any objectives for me," lamented Marcia. "The objective for the kids was to build this [ROV] and follow the MATE guidelines. I needed more specific guidelines about what my objectives were with the kids." Marcia expressed that, "The MATE guidelines were too soft. They were the final version, whereas I needed more steps along the way to get me there."

It appeared that Marcia felt unsure in her role. "I didn't really know what to do," she admitted. “Part of it was my lack of knowledge about ROVs, the technical things. I didn't really know how to guide them.”

Eddy summarized the lack of communication in a single word. Vision. “I guess it came down to the vision. I think that communication between Marcia and I was a challenge and how that played out.” Eddy also envisioned an equal share of the workload. “I hoped it would be us equally investing our time and our efforts in making things a success.”

Assumptions appeared to be a consequence of miscommunication. Eddy reflected, “I do think there were assumptions of who was doing what.” As an example, “[Marcia] built a relationship with John [Jameson], and I assumed she was communicating with him. But, then it would be me saying to her, ‘Did you email John? We could really use the high school kids.’” After a follow-up inquiry, Eddy assumed Marcia worked out a schedule for the high school students to assist the Scout ROV program. However, “I would stop in her room at 7:15 and ask, ‘Are the high schoolers coming today?’” Only to be told, “I never emailed them.” Or “I forgot.” Or occasionally, “John did not get back with me.” Chagrinned, Eddy tried to shoulder the blame “Once again, I made the assumption that when we did divide, that we were going to both get done what we [agreed].”

When asked if there was much debriefing between the two coaches, Marcia answered, “I don't think that we did much debriefing.” She went on to say there was “not much of a communication cycle.” Pretty much the only reflective conversation took place when they were in a car with each other “On the pool days when we would go to West Arbor Hills, we rode back and forth so we had opportunities to talk about how it went.”

Both Marcia and Eddy appeared to desire an improvement in communication. Eddy blamed the schedule, “I think that due to the schedule of our days as well as the schedule of our lives that there was a lack of communication.” He continued, “It was tough with our schedule. Because when we were in the classroom with the fifth-graders we were busy getting that day’s tasks done.” He agreed the communication was not cyclic, there was “Not a lot of follow up or conversation from week-to-week about how [things] should play out.”

There was an overall lack of deliberate, direct, and timely communication between the two coaches. As Eddy summarized, “When something was said, it was last minute. For example, on the mornings of the 7:30 practice, Eddy “would stop in her room at 7:15 and say ‘This is what I’m thinking. This is what I worked on over the weekend.’” Most of the time Marcia’s response was “Sure, sounds great.” So, he would proceed to the room and set things up with the rovers. Additionally, Eddy would sometimes send an “email in the morning and not get a response by 1:00. I did not want to be there until 6:00 at night so, I would just do it myself.”

The parent driver insurance verification issue provided another example of communication between the coaches that was not deliberate or timely. Legacy’s chaperone policy required insurance verification from the parents transporting students to the pool for practice. A shared spreadsheet was created so the coaches and building principal would have the most accurate and up-to-date information. Eddy discussed that he looked at the shared spreadsheet the day before the trip and realized that there were parents who were not verified. He contacted Marcia who often responded, “Oh yeah, I got this from so-and-so two days ago, here.” Marcia did not use the shared spreadsheet in the time or manner that Eddy assumed she would. As a result, Eddy said that he would “call her and say, ‘Sorry, Marcia, but I’m really trying to get this spreadsheet done. Can you send [the forms\ down [to my classroom]?” He was expecting them to be collected once by Marcia and sent to his room by a student. Instead, "Throughout the day, there would be three different kids bringing stuff down in the middle of my teaching." It does not appear that specific expectations for collecting and communicating verification data were directly communicated between the principal, Marcia, and Eddy.

Similar to Marcia's comment, Eddy stated bluntly, "I think that Marcia and I did not communicate well." However, there did not appear to be animosity between the two coaches. As Eddy took stock of the situation, he reflected, "As much as I have said about Marcia, if [we] were to do it again, the communication could increase and would increase." He continued, "I have done a better job of reflecting and thinking about how I could change it. When I was in the moment, I was just thinking about how to get it done. I was already moving down the path. I was stressed." In the future, "when this is done again, it can be more collaborative."

In summary, communication skills can have a direct impact on a person or project's success. Involvement with ROVs provides many opportunities for students and adults to communicate. However, the opportunity alone does not guarantee successful or good communication. When communication is deliberate and direct, a higher level of success takes place. There are many factors that influence the quality of communication; one of the factors is responsibility. The level of responsibility felt by individuals has an impact on the group.

Omnipresent problem-solving. At the heart of project-based learning lies problem-solving. Within the ROV experience, problem-solving can be found everywhere and in everything. Essentially, the ability to problem-solve is seeking solutions to a question or scenario. As Roger Russell said, "ROV does take a lot of problem-solving on the spot. I mean problem-solving's everywhere." In a traditional school setting, the learner is asked to answer a question that usually has a single correct answer. Often, ROV students attempt to apply knowledge to solve problems that do not have a single correct answer.

Working with ROVs, students and adults are required to adjust their mindset and apply their knowledge to solve a problem. Roger Russell has done well throughout school; however, when he entered into the robotics and ROV classes, he said, “I learn(ed) a lot of problem-solving skills.” Roger stated that he needed to “open my mind up and back away from the situation. See what's wrong and go from there.” This was a different way of thinking for him. To solve the problems posed to him, he had to logically and critically think through the scenarios to come up with a solution.

Matt Fabo reinforced Roger’s statement of backing away and looking at the situation. He discussed how often successful problem-solving skills requires focusing on the “simple things.” For example, when it comes to electricity and powering the ROVs, Matt stated that students “actually had to put the wiring together. They (needed to know) what is a circuit, a complete circuit, and a broken circuit?” He felt that if students were equipped with “some real basics, it would have been advantageous because then, in their mind, they'll find out some of the biggest problems are the simplest issues, like a loose wire.” He continued to explain that students will then think, “Why is that a problem? Well, it connects but it doesn't connect well or under certain circumstances, it breaks.” Again, he goes back to big problems often being based on “Those little things. Matter of fact they are what's going to make or break you, simplest things in the world.”

One of the difficulties about teaching problem-solving skills is that there may not be a single right answer. This type of problem is often called an open-ended problem. Even if there is a common outcome, such as a mission objective, many possible solutions exist to achieve the mission. Roger explains, “The LEGO robotics had one answer. We had to make it go in a straight line. (There) was one program and that, we could do right away.” Roger contrasted this with the ROVs, “But now it's open-ended. We can do pretty much anything we want with our robots to complete the one main mission.” Regarding preference, Roger commented, “I like doing the open-ended stuff.”

John Jameson reported that he has seen several students who were labeled *successful* in the traditional classroom environment struggle in this open-ended environment. In particular he cited a staff member’s son, “He's one of those great kids. (However), the first couple weeks in class, he was really struggling and frustrated.” John had to repeat over and over “there's no book answer.” The student finally said, “Mr. Jameson, you’re right. I don't know how to do this.” Jameson continued to work with the students, helping them to accept that there are many ways to reach a conclusion, not just a single answer.

Jameson said sometimes the students who were used to a single correct answer would get upset when other students would get a better score than they did. They would ask, “What do you mean? How come you're letting him do that?” To which Jameson would respond, “I didn't say he couldn't and I didn't say you couldn't. There's no set answer. Our job is to complete the mission or achieve the goal. Not to follow a text and conform to what everyone else has already done. I don't mind if you look at what other people have done, if that's the best way to do it, that's fine. I'm not going to penalize somebody for doing it a different way, if they achieve the same outcome or better.”

Mr. Fabo accounted for a similar phenomenon at the elementary level. He had students ask, “Mr. Fabo, this won't fit into this. Is there another way to put it together?” Matt replied, “I just give them some options. I never say ‘Well, it's not fitting because you got the wrong size gizmo.' I just say there's other ways." As Tammy Blanchard summarized, "Try. If you don't do something right, then try a different way and learn from your mistakes."

Not only is learning from your mistakes encouraged as part of the ROV groups, but Fabo also shared his experience during his career at General Motors, which encouraged learning from mistakes. "I was big on that at GM. We had programs where you would get some kind of award for a process you enhanced. I was big on giving awards to people who did something that failed because initially, it was a good idea and it made sense. That it didn't bear out in the retrospect, it wasn't even part of my concern and I fought with management a lot. I argued that it was a good idea, enough to convince us to pursue it."

Fabo discussed how this same philosophy held true with the Scout ROV group, "I applied the same here. Let them make the mistake and then figure it out." Even when things were successful, Fabo encouraged students to think about if they were to "do ROV all over again, would you do differently?" He says, "That's a huge thing because now you're benefitting from what you've done rather than just letting it slide by. You try to develop some alternative, a new path to follow."

Problem-solving often requires learners to be more self-directed, or as Roger Russell puts it, "Most of the (time) I just figure it out on my own." As both a fourth- and fifth-grade student involved with ROVs, Tammy Blanchard reported that her biggest success, was "tying the wires and not needing a lot of help from the teachers, being able to do it with just our team." Tammy said if an adult were to "ask us, 'How did you guys make this?' We should be able to tell them (how) we did it."

Matt Fabo shared a similar affinity; "I like how the kids actually were involved in coming up with their own solutions. I've never ceased to be amazed at what they can come up with on their own. Even if it's not headed in the right direction, they've got some good ideas. I'd hate to shunt any good ideas even if I know they're not going to work."

The self-directed learning holds true for adults as well as students. Eddy Scintilla shared how he prepared for leading the ROV group, "spending time on my own learning the content so I am comfortable. I also look for others that I can seek out who have experience in that field. I can then learn from them, whether it is using their ideas, building on their ideas, or incorporating their ideas with what I already know or have learned myself." Eddy continued, "I was constantly thinking, how would I have done that? How would I have built that?"

Marcia appeared to be waiting for someone to tell her what to do as the coach. "I really don't know how to guide them." She said, "I would describe myself as a person who is able to learn how to do most things, if there are clear directions. If it is that kind of learning." As she made that statement, she thought further, "Maybe that's it; maybe I need more cut and dried type of directions in order to learn things?" Marcia used hand gestures on the table to make incremental steps and said, "You do this, this, and this, and then you are done."

As classroom teachers, Marcia and Eddy anticipated the students to possess a greater amount of problem-solving skills than they demonstrated at the beginning of the ROV program. Eddy commented, "I was surprised that the kids did not have more of those problem-solving or critical thinking skills." Marcia reflected that perhaps the students "need some sort of practice solving little problems before they are thrown into something which becomes a contest."

Marcia mentioned that a person from Rebekah Wave's professional development training "suggested making a smaller practice project, like a boat with a rubber band." She continued to “wonder if maybe something that would allow them to work together and problem-solve before they actually even got to the ROV.” She then countered, “But, I don't know. I think that the kids would be too excited to wait.”

With continued candor she admitted, “The teacher in me thinks that really, I should have probably spent more time on how to problem-solve, how to get along with other people, how to design things. Some little project to start them off that wouldn't take more than a session or two. Get them working together, show them how to think about solutions to a problem. What to do when something does not work.” Eddy also reflected about teaching problem-solving and critical thinking skills, “Due to time, or perhaps my own choice, I did not consistently help them build those skills.”

Eddy and Marcia both acknowledged that they did not directly teach problem-solving skills. They gave the space for students to solve their own problems, but they did not directly instruct a problem-solving model. When asked if that would have been helpful Marcia responds, “Yeah, I think it would have helped. I think that it would have helped some groups more than others. I think that some groups needed it more than others. But, it would have helped all groups. Certainly the problem-solving might have helped.”

Problem-solving was ubiquitous in the ROV project. Problem-solving skills were the key to success with ROVs. Students were challenged to step back and look at the scenario with an open mind and come up with solutions that were not necessarily provided for them from a teacher or textbook. Students relied upon trial and error and self-questioning to help find success. Adults and students realized that often the simple details make a difference between success and failure.

Impact Themes

I identified confidence, engagement, fun, responsibility, and attendance as themes in the category of impact. The themes are powerful on their own, but combined, they created the experience and made the ROV class and clubs unique. When students were engaged with the project their confidence and attendance increased. They had fun working in their teams and would often demonstrate responsibility for themselves and their team members.

It is important to recognize that the nine themes identified in the categories of implementation and impact were not universal throughout the ROV experiences. However, when teams and individuals exhibited these themes, they experienced higher levels of success. Conversely, when the elements were lacking, individuals or teams did not do as well. For example, if a student was not engaged and did not feel part of their team, a decrease in responsibility led to infighting and the inability to complete the tasks. The following sections will provide further examples of the nine themes and how they were exhibited throughout the experiences.

Consistent confidence. The recurring theme of confidence was consistent from both student and adult interviews and observations. Confidence is the belief of being right or certain. Self-confidence is applying that sense of certitude to oneself. Throughout the ROV experience, students and adults consistently demonstrated confidence in themselves and others through their initiative, perseverance, and willingness to take risks.

At school and in the ROV project, Tammy Blanchard said she attempted to, "have confidence and try hard." Chris Perez described his group as "pretty confident." He felt he contributed to his group by openly sharing "all of my ideas." He felt confident that he provided good ideas, "to build and on how to drive the thing."

Compared to what she saw in the classroom, coach Marcia Ball was surprised by "how confident they were." Throughout the project, "They were very confident in everything that they were doing." When former students returned to Will Jackson's classroom in the elementary school and helped his current students with the ROVs, Will said, "I was able to see these kids in a completely different light." One trait that stood out most was "the confidence to be able to talk to me more like an adult to an adult." He proposed, "ROVs allow this creative aspect. They allow kids to feel a little bit more confident."

Chip Diller demonstrated confidence by taking the initiative to approach his guidance counselor about enrolling in the robotics class. "I signed up on my own. I work[ed] with my counselor to take out a class that I already signed up for to fit in robotics." Chip added, "I took the liberty of getting everything set up so I could be in robotics [the] next year."

Roger Russell is the type of student who also demonstrated confidence through his own initiative. "Throughout all my life I've excelled in math. Math comes easy to me, I've taught myself math before." Although math was a lifelong skill, it was "as a freshman, I knew I wanted to do math. I wanted to do something technical with my life." He enrolled in Jameson's "first robotics class." In that class, "I got first place in pretty much every competition, (and that) was pretty much one of the biggest events that turned my life to mechanical engineering."

As a fifth-grade student, J.T. Fabo exuded confidence. When I asked him, "What words would you hope I would use to describe you"? he replied, "Well, I hope you would say, awesome and athletic." Even though he is labeled as a student who is at-risk of not finishing high school, the idea that he might not graduate is foreign to him, "Oh yeah, of course I am graduating." He explained to me that he will be "going to college." When pushed further as to why he will go to college he replied, “sports.” He informed me he will be playing “baseball and basketball.” His grandfather is watching over him, guiding him along, and is amazed, “He doesn't seem to be apprehensive about speaking to an adult or speaking to someone of authority.”

Marcia repeated her surprise regarding the confidence of the Scout ROV groups. “They were confident and happy about what they did almost the whole entire time.” When trying to measure success of the program she responded, “What I thought most telling was their confidence, even though I thought it was misplaced in a lot of ways.” In particular, their confidence was not deterred by the “performance of their mission.”

Marcia herself does not lack confidence in expressing her abilities as an instructor. “I have taught so many years, and I have taught outside of the book, outside of the box most of those years. I have always looked at my end goals and figured out how to get there. That is the way that I have learned how to teach.” She continued, “I have a pretty secure ego and think that I can teach anything once I have enough time to figure it out.” However, she thought the ROV group might have been “outside of my expertise;” in particular, the “switches and electricity and all of that.” If given the time, “I feel I can learn anything. I think I could have learned those things had I known ahead of time or had enough time to work it out.” Furthermore, “I can figure out whatever it is the kids need to know; I pretty much have, in most cases.”

I uncovered a hint of doubt or lack of confidence in three brief examples; the first after a long discussion with Eddy. He took an introspective view saying, “Sometimes I lack that confidence in myself.” But he was quick to come back and say, “I can do this. I am going to be good at this. I feel that I will put in the time and the hard work to be successful.”

Rebekah Waves travels around the Midwest promoting ROVs. She noticed that often “adults are intimidated,” whereas, she finds it “interesting” that “none of the kids are intimidated, even the littlest kids.” Finally, Marcia admits she was “kind of intimidated by that [coach] from Tawas.”

Confidence played a crucial role with those involved with ROVs. It may be because there is a certain level of confidence required to take a risk, step outside of the status quo, and try something new. Confidence was consistently demonstrated during this experience, from enrolling in a class, to working with people who were not well-known, to leading a group in an area outside of your expertise.

Exciting engagement. A key theme that emerged from the interviews was engagement, defined as playing an active role in one’s environment. Students and adults involved with ROVs displayed an exciting sense of engagement by their actions, behaviors, words, and emotions. Exciting engagement in ROVs was emotional, possessive, hands-on, chaotic, messy, and amazing.

Coach Will Jackson "noticed emotions" being displayed with the ROV students. "There is an emotional engagement that I didn't see daily in the classroom." He described for "some groups, it came down to crying and tears to high fives" on an almost daily basis. When probed deeper, Jackson added, "The engagement with the ROV is amplified. Emotions come out with an object they are touching and feeling." Further, Jackson said, "It was probably one of the first times I saw so many different dimensions taking place in learning."

Jackson also described emotions leading to individual and group possessiveness, "like they owned it." For many it was "this thing that worked. That went from dead to alive based on their skills. To them it became this thing they created. It became alive." He added that the

ROV “becomes very attached to them. It becomes possessive.” Jackson added, for students "that are very engaged, the ROV becomes theirs." He continued, "It's theirs. It's not their pet, but it's THE thing they are working on." Will shared a story about a "student who is coming in every morning at 7:30 to work." Will said, "It belongs to him. He is taking care of it. He does not want anybody to bump into it. If anybody changes it or does anything to it he wants to know about it. He wants to have a discussion."

Coach Eddy Scintilla echoed similar ownership sentiments as he explained, “They are excited and (they) want to do. They feel ownership and would not give up.” Eddy noticed the students "took more ownership in their ROVs. They wanted to see it succeed. They wanted their group to do well." Eddy contrasts this sense of student ownership by considering “If (I as) the teacher said ‘This is what you have to do and this is your group’, maybe they would have that feeling that now, ‘I’m not engaged in this and don’t want anything to do with it’ and would maybe quit.”

Eddy feels a large part of the excited student engagement was due to “the engagement with the projects” or the hands-on learning environment. He “felt that anytime they could have a tool in their hands, the engagement improved.” He said, “If it was Marcia or I teaching or describing something, they were not always tuned in to what was going on. But as soon as they got a chance to apply it (they were engaged).” Eddy added, “I see the benefits and how engaged the kids have been and them doing the learning instead of me just providing everything and holding their hand through the process.”

Eddy noticed, “They would be more engaged with certain parts of the projects such as cutting or drilling or measuring or soldering.” Eddy said the students “want to have something in their hand and have different learning opportunities than they had in other grades or other classrooms." He expressed that "many of the students, whether it is the technology or the program, really want to have opportunities to learn in different ways." Will Jackson believed that the students "enjoyed the experience" largely "because they got to get their hands on it and build something."

Rebekah Waves shared a similar observation regarding children and ROV engagement. At her center they set up an ROV demo "in our lobby, it's not permanent, but we'll bring it out and they're not intimidated at all. They'll go right to it." She commented that sometimes the adults are a little reticent to pick up the controls, "But once they get into it, they love it. I mean, it's a total hands-on thing that's fun, even to just spin it around. And even if you don't have a big mission to accomplish, just try to get it to go in a circle or something. It's pretty amazing to see how engaged people become really, really quickly."

Dr. Jack Walton shared a similar observation. He had "Over 2000 adults, adults up in their 80s, and I did all kinds of (ROV) activities with them. The same activities I was doing with the kids, and they got into it just as much." He continued, "Recently I revisited one of my sites to do just a program for kids and, again, I saw the same response, which is the adults literally were pushing the kids away to run the vehicle in a lake to do some exploration. At one point, I actually had to tell the adults to let the kids do the vehicle." Dr. Walton believes ROVs can be engaging "for everybody."

The higher level of engagement also had an impact on behavior. Marcia observed, "Nobody stood around. For the most part, they were all doing something. There were no behavior issues. There was no hanging out in the hallways." Eddy said he was "not seeing students engaged in an activity that was not part of their team goal."

Matt Fabo agreed; he noticed that the students "seemed to know where they wanted to go with these things and, given that goal, they seemed to already know where they were headed, which was interesting. I didn't see too many sitting around thinking, ‘What do you think we should do now?’ They seemed to already know that this is the next step.”

John Jameson discussed the difference in engagement between the high school seniors in his ROV class compared to his accounting class. He felt the ROVs “gave them something to focus on. It made school relevant to them.” Will Jackson agreed, “It was real to them.” Jameson felt this was a shift for students because “The vast majority of my other seniors aren't doing anything. That’s my accounting seniors. It's just horrible.” Sam Emerson was one of the seniors in the ROV class. “Even though it was still work, you're being graded on it. I looked at it more as a reward.”

Jameson said this level of engagement was especially unique considering at-risk students who were involved. He shared a time when “I went in the teacher's lounge and (said) “You're not going to imagine, you're not going to believe this: We got a tornado of ideas in my classroom. I got (three specific at-risk boys) in there and it's like when they were building the atomic bomb and Einstein and all those guys were going nuts with those crazy ideas. That's what it was like. I was amazed. I was like sitting back going ‘Wow, did those kids really just do this?’”

Eddy Scintilla shared a similar story of an at-risk student named Judah King. “He is a student that sticks out with engagement because of the ROV. I had him in tutoring and not engaged whatsoever in any of the afterschool tutoring.” Judah became hooked with the ROV, and “offers to come in before school or after school every single day of the week.” He even “wanted to spend his recess time working.” Judah was “probably the strongest as far as making sure we had all of the tools we needed. He would check to see if the toolbox was ready." Eddy was amazed. "I saw leadership skills from him that I have never seen before."

Even more amazing for Eddy, "This was not just with the building parts of the ROV, but also how he could help his group get ready for the presentation." Eddy said, "It gave me opportunities to see his work that I would not normally see." Eddy built upon this opportunity to "challenge him" to push himself and, as a fifth-grader, "to help these third and fourth-graders with their writing."

ROVs were often a topic outside of the actual school hours and school classroom. Eddie shared, "I would hear from the kids' families that they are watching the History Channel and asking about ROVs. I would talk with parents at basketball games, and they would ask about ROVs. They would talk about the program and how they thought it was beneficial and happy that it was at the school. In the hallways, I would hear kids talk about their ROV groups."

Eddy reflected that trying to get "a written assignment on force and motion" out of some of the at-risk kids in his traditional classroom was "something that they would not have had any part of or would not want to spend any extra time before or after school on the Internet trying to learn more." However, "with the ROV, students were much more interested in learning than I have seen previously."

Eddy was impressed with the effort of the student groups for "putting in the time to work on the project or poster at home and having mom or dad involved in that process of asking or answering questions." As a student, Tammy Blanchard shared, "I'd go home and I'd look at like all of the designs and what they used for in real life." Furthermore, she looked at items around her home and wondered, "Can (I) use that to make an ROV?" According to Tammy, "I was just doing research on something and it was really cool."

Even bad weather did not deter students from being engaged with ROVs. Rebekah shared a highlight of doing research "out in the field with a fifth-grade class." She discussed how "We were able to partner up with a small film company and they came and filmed his class deploying the ROVs in Tawas Bay and doing some sampling" in Lake Huron on "a pretty cold April day." She "loved how everybody just got out."

Rebekah and the MATE center tried to increase the conversation between teachers regarding ROVs by providing exposure and training for teachers and students. She believed that ROVS "can engage at all ages at different levels" and acknowledges a big hurdle is "getting the teachers to feel comfortable." Therefore she works hard on "giving them resources for parts and practice areas to take the kids out."

Rebekah "applied for an iTest Grant from the National Science Foundation to help increase participation for Scout classes in the (MATE) regional competitions." She received the grant and, when "our grant kicked in, we got some funding to do workshops." Rebekah said the intent of their grant was to provide "baby-steps workshops." She wanted to get teachers out and excited.

To keep them going after the workshop, "The teachers that attended were sent home with PVC, motors, and cameras." Rebekah's goal was to get "people really engaged, then we'll try to hook them up with resources," including "a separate electronics (workshop) where they can do switches and stuff." Rebekah was "hopeful it will keep growing, especially with STEM. If STEM continues on (the) path that it is right now as a huge focus, I think this is a perfect thing to do."

This type of engagement can be messy and chaotic. Some people do better with this level of uncertainty than others. Will Jackson observed, "Kids that have a lot of experiences in their home and are encouraged to try new things get their hands on it and they do fine." Furthermore, "Kids that come from broken places and really chaotic environments seem to be OK with this. To them, it seems to be if it breaks it breaks; if it doesn't, it doesn't. They are not scared. They are not scared of failing. They dig their hands right in." Will continued, "I'm not saying that all kids in chaotic lives can do this. I'm saying I've noticed a group of kids that have a chaotic life that don't get bummed out when something does not work."

Conversely, Will also noticed some students who have been successful in the traditional model have a hard time "understanding that there is chaos." Will continued, "With a worksheet, if you read this article and you do this, this, and this, 90% of the time you are going to get your 'A;' that does not happen with project-based learning. It may not work. You may have done everything right and one tiny little thing could be misshapen and it falls apart." Will noticed the "group of them have embraced the idea that this is a part of life. You can work super, super hard and things may not work out." He noticed that students who have many life experiences and those from chaos seem to have a better understanding that "there are some unknowns, and there are going to be experiences that they cannot control."

As an adult, Marcia shared, "I have this conflict, this war in my head all the time. I took from the ROV that the engagement is good and you have to get over all of that other stuff that bothers you about it." When asked what bothers her about it, she replied, "It's messy, it's chaotic. I get nervous about doing it. I believe in my mind and heart that it is right, but then I start thinking about social norms, and it's like, eww."

Marcia explained, "I believe the engagement is important. I believe it's important. But, then there is the noise level. That becomes an issue. I start to worry about what are they thinking on the other side of the wall? Is this too loud for (the next) room"? Marcia admitted, "I back off of keeping them engaged. Because even if you do have the activities and keep them engaged, there is the noise."

Eddy found that "when it was organized and well laid out from the coaches and instructed to the kids, then they were engaged and more comfortable." He acknowledged that "how Marcia and I presented the materials" had a significant influence on student engagement. For example, "How organized or laid out it was helped the students feel prepared." Furthermore, Eddy believed that "when they (the students) could connect what we were saying to other ideas or experiences or something in front of them the engagement improved."

Eddy thought students were more engaged when they were responsible for specific tasks. If there "was a group of three, and we approached them and said we need three boxes wired and tethers finished, it was hard for them to know who should do what." However if the same "group of three students were given specific tasks; and student 'A' is doing the cutting, student 'B' the stripping, and student 'C' the soldering; there was much more engagement."

Eddy said it helped the students if the adults laid out "the day's tasks." It appeared that the students were "more engaged and wanting to participate as well as improve their ROVs." An additional benefit of the students knowing their tasks was, "once they had their hands on the tools or materials, it allowed me to move around the room and allowed the students to engage with me."

Will Jackson believed that "engagement is where the joy comes from." He tried to get students and adults both to "just engage in it. If it works, that's OK." He said with project-based learning, "enjoy the process, not the outcome all of the time."

ROVs have provided opportunities for students and adults to be engaged while learning. This was exciting for the individuals involved and for those witnessing the engagement. The process can be chaotic and messy, but organization and specific tasks help make it easier. Engaged individuals and groups displayed positive behaviors and developed a sense of ownership that extended beyond the school walls and school days.

Memorable fun. Defined as a sense of enjoyment, fun was so memorable it was mentioned when describing the people, the robot, and the process of being involved with ROVs. Over and over again the word *fun* was used to describe the ROV experience. This section provides examples of why students found ROVs to be fun and the impact fun had on learning. Jesse Tanner summarized the experience in a single sentence. “When I got home I would still be thinking about that one class, not really any others. I think it's because I had fun in that class.”

It appeared that having fun was a large variable in enrolling in a similar class or joining a similar club. Tammy Blanchard said she would continue with ROVs, or a similar mission-based club because she was “liking it, having fun, and learning different things.” She said the only reason she may stop is if she “lost interest.” J.T. Fabo echoed a similar response when asked if he would enroll in a similar club. “Yes. It was really fun.” Jesse Tanner reflected, “At the end of the class period I would be like ‘Are we really done with this already?’

Chip Diller also discussed the challenge/fun relationship. “I had a great time. It was something I really enjoyed. It was always fun. I liked the struggle to get something to work, that was always fun. Having that drive, that motivation, was a good feeling. Then the relief when you finally get it to work it's like, Yes, got it to work! I had a great experience the whole time." Jesse Tanner echoed a similar memory, "I thought it was fun. It was challenging." Jesse and Chip both appeared to have found fun within the challenge.

Will Jackson shared his perspective of what interested the students, "They know it is fun. They know it is fun and there are a lot of kids asking about it. So, that in itself is a fresh feeling." Marcia Ball thought students liked the ROV club because, "it wasn't school. It wasn't a graded assignment. I think it was very important for them. They enjoyed it." Marcia expressed that doing well in the competition was "something we want for them, but if they just go and have fun, that's okay too."

Although most of the students appear to like Springfield Public Schools, there was a marked difference between the enjoyment levels of the ROV classes compared to the traditional classroom format. Not only does Chip Diller call his ROV class "a really fun class," but also, he stated, "It was better than other classes." He elaborated, "I can't remember every single lecture or can't remember every single test [from my English class}, but in robotics I can remember almost every step. It was because it was fun. It was enjoyable." It was a definitive memorable experience for Chip. Roger Russell reflected, "I enjoy doing the mission stuff more, and I'd rather be in robotics than calculus, but I know I need the calculus." Outside of Springfield, Rebekah Waves said she "feels bad for the classroom teachers" because "Every time [I work with kids on ROVs] they're like, this is so much more exciting than reading or writing in the classroom."

When I try to home in on what makes ROVs fun, often it relates back to involvement. Chris Perez shared, "It makes school a lot more fun than just sitting there writing the whole day. It's a lot better because we get to actually interact and, at the same time, we're having fun and learning." Similarly, J.T. Fabo expanded, "It's more fun. It's not just sitting and listening. You get to do stuff. It's a lot more fun." Jesse Tanner concurred and added, "That was definitely the class that I wanted to go to. That was the class I couldn't wait to get to. It was one I actually had fun in rather than sitting there listening to the teacher instruct." Jesse continues, "It was more fun than sitting there at a desk all day and doing book work and filling out math problems."

Hands-on is another term used to describe why students identified ROVs as fun. Jesse explained, "It's hands-on and the teacher tells you what to do and you have to figure out a way to do it." Tammy Blanchard described working with the ROVs "different" than her normal classes. She elaborated, "Normally in class you're not very hands-on, but in ROV you're building, and it's very hands-on." She said she has learned "to try, and if you don't do something right, then try a different way and learn from your mistakes." She again described this type of learning as "a lot of fun."

Coach Scintilla reflected, "It was fun for me because it was truly hands-on. I was able to be part of their learning in that hands-on experience." He stated that this was different for him because he was learning alongside the students "Instead of just asking for something back in pencil and paper." He added that he enjoyed the complexity of managing behavior, groups, and work. "To manage behavior as well as where they were at (Are they ready to work on their presentation? Are they working on their circuits? Have they completed their tether?), it was fun for me to see them grow, to see them balance those things. It was not just one thing I was working on." He also commented, "I was constantly thinking, How would I have done that? How would I have built that?" For Eddy, the process "was fun for me to learn alongside them, and that was cool."

Working with ROVs is a unique experience. There is fun found within the uniqueness of building robots to drive around underwater. Michael Long most remembered, “how fun it was to drive.” J. T. Fabo was not surprised that everyone stayed with the project from beginning to finish. His explanation as to why nobody quit or was asked to leave: “It was a fun experience. It's not every day that you get a chance to build an underwater vehicle.” As a rover, J. T. was granted a larger exposure behind the scenes. He thought this work was, in a word, “fun.” When asked for examples he replied, “I would set up the coral and everything. I learned how to build stuff, how to use a control box, how to solder. I [have] never done that. It was fun.” Furthermore, as a student from a district without a swimming pool, he thought, “It was really fun to go in the water.”

Tammy says she will most remember “the fun, the different challenges, and how much fun we all had together building and seeing if it would work.” Cal Naughton had fun with his group, but he also offered the following caution, “I learned that having fun is not all you have to do. If you have too much fun, you are never going to get it done and working properly.”

In summary, students overwhelming conveyed that having fun while learning was important and memorable for them. They had fun when faced with challenging work assignments. The students did not shy away from challenging work; instead, many said they worked harder because they were having fun. Unique hands-on work that produced results was enjoyable for elementary and secondary students and adults.

Students also enjoyed the social aspect of learning with ROVs. They had fun because it was more active and social than their traditional classes. The hands-on learning allowed students to physically manipulate their work, and many students found this to be fun. They also enjoyed learning from their mistakes and did not feel penalized for not finding the single correct answer. The adults had fun watching the students grow and overcome obstacles and doing well in their assigned tasks and missions. Having fun also appeared to impact students, as witnessed by the volume of people who used this word to describe their experience.

Personal responsibility. A theme that emerged from the data was that of personal responsibility. Responsibility is being able to answer for one's conduct and obligations. It is synonymous with commitment and duty. There were many examples of responsibility demonstrated and witnessed throughout the ROV projects.

Chip Diller felt more responsible for his grades in the high school robotics class than he did in traditional core classes. Chip stated, "We were given responsibility for our grade, this is something that is new." Chip said other teachers gave him grades and would "ask him questions about his assignments and why his grades were low," but Mr. Jameson felt the students "can take the responsibility to come up and ask why it's down." Further, Chip said, "Most teachers still don't do that responsibility thing." Chip noted you could improve your grade in Jameson's class, "but he didn't force you to come if you had a low grade." Chip's transcripts confirmed that he kept an *A* in John Jameson's class.

Chris Perez would like people to describe him as "Nice, responsible, and athletic." His mother believed, "He needs to be more responsible for his learning." She said, "Over the years all he has to do is flash that cute little smile of his and flash those shiny brown eyes, and [the female teachers are] like, 'Oh Chris, we love you. You're so sweet. Let me look in your desk for you and see if you didn't turn in that paper.'" She reflected that during the last year, "He's come a long way. But I don't think he's responsible enough." However, she believed that he was much more responsible for "his attendance and attitude" in the ROV club than he was during the school year.

Roger Russell joined the high school ROV program as a sophomore and was involved with the program through his senior year. Roger did well in school, as affirmed by his transcripts (*A*s) and his math ACT score (32). As a member of the ROV team Roger demonstrated responsibility in several ways. On an individual level, Roger said that he "pretty much [got] done with my robotics stuff before anybody else." He maximized his time by "using [Mr. Jameson's] class[room] to get (his) homework done." Since he joined as a sophomore, Roger developed into a leader on the ROV team. He admitted that he sometimes has difficulty delegating work to others because, "I feel like I need to do everything since I've done it before and I know what I'm doing." However, he recognized the need to help his peers learn from their mistakes, "Sometimes I redo it, other times I tell them what to do, and then have them redo it." A new student joined the team this year, "He doesn't really know very much around the shop or doesn't do stuff like measure twice cut once. [I] watch over him and make sure everything's [done] the right way." Roger hoped that, in turn, the new student will share the responsibility and "watch over us, too, because we make mistakes."

As a coach, Marcia attended all of the practices and events for the Scout group she was leading. However, there appeared to be a difference in responsibility between herself and Eddy. Marcia reflected, "I noticed part way though it that they were not seeing this as the same way I was seeing it. I kind of backed off and just decided 'I'm not going to worry about it.'" It appeared as if she knew that she was being irresponsible, and tried to justify her "backing off" by explaining, "Part of it was my lack of knowledge about ROVs, the technical things." She then blamed the format of the club, "I didn't really know how to guide them. It was an open-ended club session. There wasn't (sic) any objectives for me. The objectives for the kids was (sic) to build this and follow the MATE guidelines. Other than that, I didn't really know what to do." When asked what would have helped her, she said, "I did not have any guidelines myself. I needed guidelines so I could then share those guidelines with the kids." Marcia, closed the interview stating, "I think I could have been more useful if I could have taught them, or at least guide them, to some knowledge in a more direct way."

While Marcia backed off, Eddy experienced an increased burden of responsibility, "From pool time, the all-call, the notes home." He did this, "Out of respect to the kids, the timeline and the families I did my best [to get things done]." Further, "I put a lot of it on myself, as far as going to Home Depot or Lowes buying things, or building things, or tinkering with things. I was hoping [the responsibility] would be more shared and it wasn't." Eddy also tried to increase his level of responsibility by learning new skills, "Like the All-Call System." He said, "If [my principal] can show me, then that's a tool that I can have and I can use, then I can do it on my own." This responsibility "was an added thing I put on myself, but those little pieces can help me."

Students and adults made choices about their personal responsibility to their ROV team and themselves. Many showed respect toward each other through their commitment of time, knowledge, and willingness to serve. Some showed traits of irresponsibility and pulled back from their group. Many took the space and freedom provided and acquired new skills and experiences. An area for adults and students to demonstrate personal responsibility and teamwork was seen in attendance.

Increased attendance. One of the factors that contribute to a student being at-risk of not graduating from high school on time is missing 15 or more days of school per academic year, an attendance rate that is less than 92% at Springfield Public Schools. The average daily attendance rate at Springfield Public Schools is 93%. The inaugural ROV club at

Legacy consisted of 52% at-risk students. Of that group, 36% were considered at-risk due to their attendance history. Half of the students in the first ROV group at Springfield High School were considered at risk of not graduating on time. Of that group, 25% had attendance patterns that placed them into the at-risk category.

Once involved with ROVs, a noticeable difference in student attendance patterns occurred. At the elementary level, Will Jackson was pleasantly surprised by the impact the ROVs had on student attendance. He recalled, "Students wanting to come to school when they are sick." He remembered "Parents calling and saying 'so-and-so is sick this morning, but they really want to come to school.'" Peer pressure worked in a positive way, as the students "were held accountable by their peers" to show up to school. Jackson said, "I have never seen (that) before."

Marcia thought that the club "attendance was amazing." Eddy reported, "great attendance." He said that the attendance rate of the extended-day ROV club at Legacy was "pretty much 100% throughout." Eddy explained about the rare case of absences from the Legacy ROV club, "The times that we did have a kid missing, the parents let us know why they were out." It boiled down to "an extended spring break or illness."

Chris Perez was an at-risk student and a member of the Legacy ROV club. Chris's mother "had reservations about him joining a group that met before school." She continued, "He is not an early riser. He was late almost every day. Look at his (school) attendance." Chris shared that in his fifth-grade classroom, "We did this writing assignment every morning; it was (worth) ten points. Some days I didn't get it finished because I would wake up late. I would get to school late. I would have only had the time to write half a paper. So, I'd only get five points." The school secretary at Legacy said Chris was tardy "quite a bit."

However, once the morning ROV program started Chris rose to the occasion. His mother beamed, “He attended every single time, and on time!” When asked if he preferred the fourth-grade, school-day ROV experience or the before-school, fifth-grade experience better Chris replied, “I liked before school.” He continued, “I got to wake up earlier and be at school before (the other students). I liked to see how it was (before students arrived).” Further, he enjoyed “going to all these pools and driving at pools.”

The high school students also displayed increased attendance that was outside of the normal attendance parameters. At the high school level, John Jameson stated, "I had kids that would come in after school or before school or on their lunch and work on it." He noted, “It drives (the lunch supervisor) nuts” when the students would leave the cafeteria to work on their robots. Several times he had to tell her, “It's alright, just let them come back here; they are not hurting anything.” Often, the students would “bring their friends,” and Jameson would “use it as a recruiting tool.”

Attendance rates were higher than average school day attendance for students, including at-risk students, involved with ROVs. This was evident during school as well as non-class times such as lunch and outside of school hours. This increased attendance was witnessed at both the elementary and secondary levels.

Open coding led to the themes of time, teamwork, communication, and problem-solving related to the implementation of the ROV projects throughout Springfield Public Schools. The themes of confidence, engagement, fun, responsibility, and attendance provided examples of at-risk students being impacted by their involvement in ROVs.

Chapter Six: Conclusions And Implications

Following the Grounded Theory format (Charmaz, 2006) and axial coding, the process of relating codes to each other, four crosscutting themes at the heart of the ROV experience were identified. Findings indicated that student **Motivation** was impacted by **Hands-On Learning** that was **Perceived** to be **Relevant.** Each conclusion is supported by the literature review and findings from this study. Figure 8 provides a summary of the conclusions.

Motivation	• Task involvement increases motivation. • Demonstrate success through very specific tasks. • Autonomy, Mastery and Purpose base of intrinsic motivation.
Hands-On Learning	• Brings content and curriculum to life. • It's about thinking and solving problems.
Perception	• Influences how we behave and act. • A desire to complete task aligned with ability to complete task. • Specific and deliberate communication.
Relevant	• Improves academic relevancy. • Leads to higher engagement and intrinsic motivation. • Makes curriculum meaningful.

Figure 8. Summary of conclusions.

Motivation

Researchers and psychologists have studied motivation for hundreds of years. Achievement motivation and how it relates to the students and adults involved in the Springfield ROV projects are examined in this section. Elliot (2007) defined achievement motivation as “why and how people strive toward competence (success) and away from incompetence (failure)” (p. 6).

Walberg (1984) and Fyans and Maehr (1987) documented the relationship between motivation and achievement. Walberg found motivation explains 16–20% of the variance found in student achievement. Fyans and Maehr found that motivation explained up to 35% of the variance in student achievement. Within the past 25 years, achievement motivation has emerged as one of the most prominent theories of motivation (Anderman & Wolters 2005; Pintrich 2000).

Nicholls (1984) stated that people attempt to demonstrate achievement behavior through either task involvement or ego involvement. The choice for which involvement to use to demonstrate success often depends upon an individual’s goals, ability, effort, and skill. When individuals are task involved they see “more effort leading to more mastery and higher ability” (Nicholls, 1984, p. 332). Demonstrating ability in ego involvement is focused around self-esteem or self-concept and often demonstrated in relation to others ability to perform a task or objective.

Ego often involves social comparison. As students get older, they compare themselves to others and decide that they are good or bad at something as it compares to others. Applying achievement motivation, students become too ego-based and often quit or do not push themselves because they do not want to look worse than their peers. Many researchers point to school systems as ego-based systems fueled by extrinsic motivators such as grades, rewards, trophies, and report cards.

According to such researchers as Yang, Tsai, Kim, Cho, and Laffey (2006), goal orientation plays a large role in motivation. Goal orientation can be categorized into intrinsic and extrinsic orientations. Intrinsic goal orientation centers on students engaged in activities based on traits such as curiosity, task challenge and improving or perfecting of mastery (Amabile, Hill, Hennessey, & Tighe, 1994; Gottfried 1990; Nicholls, 1984). Whereas, extrinsic goal orientation is similar to ego in which students perceive themselves as engaging in a task because of grades, rewards, performance, evaluation by others, and competition (Pintrich, Smith, Garcia, & McKeachie, 1991).

Pink (2009) suggested that schools are often based upon “contingent motivators,” meaning if you do this, then you get that. For example, if you show up for class and do your work, then you will pass to the next grade. Contingent motivators often work when a simple set of rules could produce a clear outcome. Because our current school systems were designed to produce 20th century workers who could do a specific task and be compliant, these extrinsic contingent motivators often worked.

However, the 21st century economy requires a higher percentage of the population to think differently than in the past. People need to be well-versed in complex problem-identifying and problem-solving. Pink (2009) cautioned that extrinsic motivators or rewards limit our focus and do not allow us to look at creative or unique solutions. He said, “For a lot of tasks, they actually don’t work and often they do harm,” whereas intrinsic motivators allow people the space to solve more complex problems (quoted from video, August 25, 2009).

Pink (2009) contributed the following intrinsic elements as the basis of motivation: Autonomy–the desire to direct our own lives; Mastery–the urge to get better and better at something that matters; Purpose–the yearning to do what we do in the service of something larger than ourselves. ROVs produced many task involvement opportunities for individuals to engage in Pink's three intrinsic elements of motivation.

Motivation is witnessed in this case study. As an axial theme, motivation cuts across many of the open themes such as engagement, problem-solving, confidence, teamwork, and fun. The following subheadings provide specific examples of motivation's impact on student learning.

Motivation as engagement. ROVs allowed students to be engaged with specific tasks that had a specific purpose, which led to a higher level of mastery. For example, Eddy Scintilla witnessed motivated students who were "engaged with certain parts of the projects such as cutting, drilling, measuring, or soldering." Eddy found the more specific tasks also led to greater engagement. He felt if there "was a group of three and we approached them and said we need three boxes wired and tethers finished, it was hard for them to know who should do what." However if the same "group of three students were giving specific tasks and student A is doing the cutting, student B the stripping, and student C the soldering, there was much more engagement."

Eddy described how Judah, a fifth-grade student, engaged with a sense of purpose and "offers to come in before school or after school every single day of the week." He even "wanted to spend his recess time working." Judah was not focused exclusively on the building aspect of the ROV. He did a great job managing. Before any trip to the pool or a build time, he "made sure we had all of the tools we needed. He would check to see if the toolbox was ready." Judah's sense of purpose allowed him to be engaged at a level unseen in the traditional classroom environment.

Eddy was motivated to organize the directions, missions, and supplies because "when it was organized and well laid out from the coaches and instructed to the kids, then they were engaged and more comfortable." Eddy went on to say, "It helped the students if the adults laid out the day's tasks." Eddy said it appeared that the students were "more engaged and wanting to participate as well as improve their ROVs." An additional benefit of the students knowing their tasks was "once they had their hands on the tools or materials, it allowed me to move around the room and allowed the students to engage with me."

Eddy felt that a greater sense of autonomy was because the students could focus on the tasks and not worry if they were doing things correctly as compared to others or even a perception of what Eddy and Marcia wanted from the students. Students were free to create their ROV in any manner to complete the missions.

Motivated to solve problems. Roger Russell stated that when it came to ROVs, "problem-solving's everywhere." With project based learning in general, and ROVs specifically, there is rarely a single correct answer; and when there is, it is often not the traditional path to discover the answer. Some people struggled with this concept.

John Jameson shared a story of a "great kid" who flourished for 12 years in an educational environment playing by the rules of contingent motivators. However, in the ROV multi-solution environment he struggled with problem-solving that did not have a simple single answer. It took him a couple of weeks of "really struggling and (being) frustrated" before he could tell Mr. Jameson, "I don't know how to do this."

On the other end of the spectrum, as he was able to solve problems in many unique ways, Roger found a new sense of autonomy. Roger discussed the first robotics class in which he was enrolled, "We had to make it go in a straight line. (There) was one program and that we could do (it) right away.” Roger contrasted this with the ROVs, “But now it's open-ended. We can do pretty much anything we want with our robots to complete the one main mission.” Regarding preference, Roger commented, “I like doing the open-ended stuff.”

Matt Fabo discussed how he attempted to guide the students to discovering answers as opposed to giving them a specific answer, “I just give them some options. I never say ‘Well, it's not fitting because you got the wrong size gizmo.’ I just say there's other ways.” Tammy Blanchard essentially described the problem solving as, “Try. If you don’t do something right, then try a different way and learn from your mistakes.” Tammy stated that, as both a fourth and fifth-grade student involved with ROVs, her biggest success was “Tying the wires and not needing a lot of help from the teachers; being able to do it with just our team.”

When students were engaged with these tasks, they were not comparing themselves to others. If a solder needed to be done, it was not necessarily based on who had the prettiest solder in the class. Instead, if the solder was successful, the ROV worked. If it was not successful, the ROV would not work. The more often the students did the specific task, the more they felt that they mastered the skill. This led to increased levels of confidence.

Motivated as confidence. Chip Diller proudly explained how he confidently displayed a sense of autonomy when he met with his guidance counselor to enroll in the robotics class. “I signed up on my own. I work[ed] with my counselor to take out a class that I already signed up for to fit in robotics.” Chip added, “I took the liberty of getting everything set up so I could be in robotics [the] next year.”

Marcia noticed that for some students, "Their confidence was not deterred by the performance of their mission." This again showed the power of project-based learning for overriding the ego involvement. If pushed, the students could remember times where they may have not been able to complete their mission, but it was never something they brought up on their own. Whereas, when I spoke with them about their grades in class, they were quick to give me examples of a low test score or incomplete work.

Chris Perez told me "We did this writing assignment every morning; it was ten points. And some days I didn't get it finished cuz I would wake up late; I would get to school late. I would have only had the time to write half a paper, so I'd only get five points." However, even though Chris and his team received points for the Showcase, Chris claimed the earned points were not the motivating factor.

Will Jackson shared that for some students it takes about two weeks for them to overcome their fears of "breaking this futuristic thing." He said they are also afraid of "letting someone else down and the fear of failure," as well as "breaking it and somebody getting mad, or to get in trouble." However once they start realizing they can get their "hands on it, to maneuver it, to change it, they do better."

Motivated to work as a team. Butler and Cartier (2005) explained, "Students' understanding about a task is a key determinant of goal-setting, strategy-selection, and criteria used to self-assess outcomes" (p. 30). The mission goals were often set for the students; however, the strategy selection and criteria used to self-assess outcomes was often left to the groups.

Again, these skills are not prevalent in the traditional school environment. Both Will Jackson and John Jameson discussed how they spent time working with students, leading debriefing meetings, and modeling to students how to self-assess outcomes as a group. This led to student-created pre- and post-dive checklists and increased team decisions. For example, at the high school level when trying to determine drivers, Chip Diller felt that demonstrating skills such as “turning the ROV around in the trough” qualified him to be the driver. It also led Roger Russell to push for redundancy in his team. Roger made sure that each person in the group “knew how to work the cameras and stuff on the robot.”

When students displayed a sense of autonomy, mastery, and purpose, it also had a positive influence on behavior. “Nobody stood around. For the most part they were all doing something. There were no behavior issues. There was no hanging out in the hallways.” Eddy said he was “not seeing students engaged in an activity that was not part of their team goal.”

Another example of autonomy was choosing the members of the elementary ROV teams. Students were able to pick the members of their groups. Jacob Favre is an at-risk student who picked his team members because “I knew them for a long time, and we have been pretty good friends for a while.” He felt they would work well together because “we could work things out.”

Conversely, Springfield High School had an introductory ROV group that lacked purpose. This group was very ego-driven and the prevalent social dynamics created a divisive mentality that took hold of the group. Students did not use the autonomy granted to them to enhance their learning; instead they hid in the shadows of the advanced ROV group that went overseas. As the advanced group was in the island nation of Kiribati, the intro group shirked their responsibilities. Some behavior issues escalated and led to a student assault with the assailant being suspended from school. It is important to realize that the project alone will not eliminate the ego influence, especially in older students; students need to truly own the project.

Ego was present in motivating Marcia when she "noticed part way though it that they were not seeing this as the same way I was seeing it. I kind of backed off and just decided 'I'm not going to worry about it.'" Marcia's actions were in contradiction to her words of claiming possession of "a pretty secure ego" and the ability to "teach anything once I have enough time to figure it out." However, she did not feel she had the time or "knowledge about ROVs and didn't really know how to guide them." To avoid failure, Marcia's ego motivation gravitated her towards task avoidance. However, she was candid and honest about her withdrawal.

Motivated by fun. Throughout the interviews and observations in this study, the word *fun* was consistently used to describe the ROV experience. When people felt a sense of autonomy, mastery, and purpose they also possessed a sense of joy. The joy the students experienced was not based on work avoidance; instead it came from truly being involved with the work.

Jesse Tanner told me, "When I got home I would still be thinking about that one class. Not really any others. I think it's because I had fun in that class." Chip Diller echoed a similar sentiment, "I can remember almost every step. It was because it was fun. It was enjoyable." Specific tasks were also considered fun. Michael Long most remembered, "How fun it was to drive." J.T. Fabo said, "I learned how to build stuff, how to use a control box, how to solder. I [had] never done that. It was fun."

Fun is a powerful motivator for learning. However, in many learning environments, not only is it overlooked as an indicator of learning, many people deem having fun in school as an absence of rigor and learning. Rarely is fun measured, let alone reported. However, Pink (2009) reminded us that the sense of purpose and mastery are strong motivational influences, and having fun is naturally associated with motivation.

Many factors contribute to reasons that students were motivated to participate in the ROV club, class and unit. The factors do not need to be exclusive. However, when task motivation can eclipse the social comparisons of ego, a deeper sense of learning is taking place. Perhaps, Eddy summed it up best when he said, "I was constantly thinking, 'How would I have done that? How would I have built that?'" Which Eddy perceived as being "fun for me to learn alongside them, and that was cool."

Hands-on Learning

This study looked at learning that could be described as hands-on. It's not a new form of education; Dewey (1938) advocated "periods of activity in which the hands and other parts of the body beside the brain are used" (p. 10). However, it has not been the dominant form of instruction in the American school system. One reason is that during the last century schools have been places to produce compliant workers to fill the needs of an industrialized country. For the most part, the *school syst*em has been based on the production line model. Students enter at a set age, move up a grade each year, and at the end of high school are ready to enter the "real world."

The world has changed; there is a larger demand for people to be creative problem-solvers who are willing to persevere through many obstacles and changes. Hands-on, minds-on learning helps students be creative problem solvers. More than a decade ago, The National Research Council (2000) emphasized the importance "to respond to questions, formulating explanations using evidence, connecting new explanations to prior scientific knowledge, and communicating explanations and justifications to peers” (p. 29).

The new way of learning proposed by the National Research Council (2000) was seen at the elementary and secondary levels through students working in teams to create remotely operated vehicles designed to operate underwater to achieve a specific task. As an axial theme, hands-on learning cuts across many of the open themes such as engagement, fun, time, teamwork, and problem-solving. The following subheadings provide specific examples of hands-on learning.

Engaged with hands-on learning. I think Eddy described it best when he said, “Anytime they (students) could have a tool in their hands the engagement improved.” Outside of specific vocational classes, usually at the high school level, it is a rare occasion to see students using actual tools in their learning. The usual school tools are pencils, calculators, and protractors, better known as office supplies. In the ROV classes, students were engaged and excited to have their hands on actual tools found in hardware stores.

Perhaps it was because it was unique, but when they were “cutting, drilling, measuring, or soldering” the students were focused and engaged. The students really “want to have something in their hand.” Again, based on how the students behaved, Eddy was convinced they wanted to “have different learning opportunities than they had in other grades or other classrooms.” He went further and added, “Whether it is the technology or the program, (students) really want to have opportunities to learn in different ways.”

Will Jackson has worked with elementary and secondary students using ROVs. He noticed a similar response from the students and felt they “enjoyed the experience” largely “because they got to get their hands on it and build something.” Outside of the classroom, and in NOAA’s Tawas Bay marine sanctuary, Rebekah Waves would often set up an ROV demo “in our lobby.” She noticed that “as soon as it is set up, students go right to it.” Although not building the ROV, they would attempt to drive it around the pool. There were always people waiting to do this hands-on activity at the sanctuary. Regarding the children’s’ willingness to put their hands on an ROV, she noticed, “they're not intimidated at all.” Further, “Even if you don’t have a big mission to accomplish just try to get to go in a circle or something. It’s pretty amazing to see how engaged people become really, really quickly.”

Like many things that are different, there are obstacles faced in hands-on learning. Tough (2012) discussed three strategies people use when facing obstacles. The first is indulging, “which means imagining the future they’d like to achieve” (p. 161). The second is dwelling, “which involves thinking about all the things that will get in the way of their goal” (p. 161). Not surprisingly, neither of those strategies produces a high level of success overcoming obstacles. However, combining the two in a method called *mental contrasting* appears to lead to higher levels of success. Mental contrasting means “concentrating on a positive outcome and simultaneously concentrating on the obstacles in the way” (p. 162). For many adults involved with hands-on learning, mental contrasting means focusing on the student enthusiasm and excitement generated by projects while not only being aware, but addressing some of the obstacles that come along with doing something different.

Eddy has been taught and trained that the teacher has content knowledge and it is the teacher’s responsibility to pass it on to the students. During the ROV experience, Eddy was challenged to adjust his schema. “I see the benefits and how engaged the kids have been and them doing the learning instead of me just providing everything and holding their hand through the process.” Basically, you cannot be hands-on if someone is holding your hand.

Marcia discussed her conflict with hands-on learning. I believe Marcia sincerely wants to help students learn. She said, “I think of myself as a teacher, not as a third-grade teacher or a second-grade teacher or whatever else.” She sees herself as a teacher first. Marcia was not educated in a hands-on environment, “It was all very page one, page two type of instruction.”

Marcia wants to be a teacher who provides an engaging hands-on learning environment for her students. “I believe in my mind and heart that it is right.” However, there seemed to be reservation. When asked what bothered her about it she replied, “It's messy, it's chaotic. I get nervous about doing it.”

Furthermore she was concerned about the disapproval from her peers and “the powers that be.” She admitted to the conflict most when “I start thinking about social norms and it's like, eww.” As an example, she used “the noise level.” She stated, “I start to worry about what are they thinking on the other side of the wall? Is this too loud for (the next) room?” “I back off of keeping them (students) engaged because, even if you do have the activities and keep them engaged, there is the noise.”

Research supported that Eddy and Marcia adjusted their schema. Randler and Hulde (2007) conducted experiments comparing student responses to hands-on labs versus teacher-centered activities. They found, “learner-centered experiments and lab-work tasks may provide a better retention compared to a teacher-centered presentation of experiments” (p. 334).

One of the strategies to help teachers overcome their sense of uneasiness for doing hands-on projects is providing hands-on professional development. Custer and Daugherty (2009) reviewed several professional development activities with particular interest on engineering. They noticed that K-12 teachers participating in hands-on professional development often shared the following characteristics, “teachers were engaged in exciting activities, worked with well-developed curricular materials, and interacted with one another in constructive and positive ways” (p. 23).

Rebekah Waves used this hands-on professional development model to promote teacher involvement in ROVs. She received an iTest grant from the National Science Foundation that included “some funding to do workshops.” The workshops were led by Rebekah and included “baby-steps” to help the teachers learn how to build not only the ROV but also a club or group within a school.

Students and adults can increase their level of engagement by participating in hands-on learning experiences. Being hands-on is one of the most memorable experiences that the students and adults took away from the ROV projects. Hands-on opportunities can be messy and loud. However, good management techniques can help guide students and adults over these obstacles.

Hands-on learning is fun. There is a perception in our culture that having fun while working is frivolous and lowers the value or quality of the work (Ford, McLaughlin, & Newstrom, 2003). However, having fun and joy can have the opposite effect. It can inspire and motivate people to work harder and learn more. A fun work environment is a valuable asset for organization (Ford & Heaton, 2000). Kouzes and Posner (1995) stated, “If you and others aren’t’ having fun doing what you’re doing, chances are people aren’t doing the best they can do” (p. 59). Students at the elementary and secondary levels had fun participating in the hands-on nature of ROVs.

Jesse Tanner explained some of the key distinctions of the ROV class, “It's hands-on, and the teacher tells you what to do and you have to figure out a way to do it. It was one I actually had fun in rather than sitting there listening to the teacher instruct." Jesse continued, "It was more fun than sitting there at a desk all day and doing book work and filling out math problems." Jesse's experience with the hands-on nature of the ROV class aligned with Randler and Hulde (2007) findings, in which a "hands-on and learner-centered approach was rated as more interesting, reflecting the interest of pupils in doing experiments on their own" (p. 336).

Outside of school, Jesse also sought to balance hands-on learning and fun. He also held down a part time job with a landscaping company, He found the landscaping to be hard work, but also enjoyed the hands-on nature of the job.

J.T. Fabo consistently mentioned how important it was for him to be able to move and have fun. "It's more fun; it's not just sitting and listening. You get to do stuff. It's a lot more fun." As a rover, J.T. essentially provided assistance to the multiple ROV teams. The need for him to move throughout the classroom helping other groups was met by his desire to do more than sit and listen.

Chris Perez stated the hands-on work "Makes school a lot more fun than just sitting there writing the whole day. It's a lot better because we get to actually interact, and at the same time we're having fun and learning." Corter, Esche, Chassapis and Nickerson (2011) found students had "a preference for the hands-on labs. This is not surprising, since the hands-on format is the most immediate and vivid" (p. 2064).

It was important to notice that the students did not talk about having fun in isolation. They quite often talked about having fun and hands-on learning, reinforcing the belief that students want to learn; having fun and learning do not need to be exclusive. Unfortunately, this is not commonplace in the traditional school environment. As an example, Tammy

Blanchard described working with ROVs as “different” than her normal classes. She elaborated, “Normally in class you’re not very hands-on. But, in ROV, you’re building and it’s very hands-on.” She again described this type of hands-on learning as “a lot of fun.” Hands-on interaction is a key characteristic to experiential education; having fun while interacting brings another level to learning.

Hands-on learning takes time. Hands-on learning is not as efficient as worksheets and standardized testing. It takes longer for the teacher to prepare lessons and materials. Toth, Morrow, and Ludvico (2009) stated, “inquiry learning is time consuming and resource-intensive” (p. 334). It also takes more time for the students to work through the project. Toth et al., (2009) also reported that the students engaged in hands-on activities spent the most time writing lab reports, discussing, and analyzing data.

Students and adults both recalled time spent engaged in the hands-on components as highlights of the experience. Jesse Tanner had the opportunity to work with his ROV team in 90-minute periods. Even with that extended time to work, Jesse suggested it would be beneficial to have even more time. He justified this request because, “it's more hands-on so it's more time consuming.” However, asked about his traditional classes, he said the only reason he liked the 90-minutes was to complete his homework.

During the ROV club, the students attended an hour-long session twice per week. Reflecting on the experience, Eddy wished he would have spent time on “Not just the build part, but spending more time on the circuits, more time on learning the components of the ROV and the real world connections.” Eddy was concerned whether the students had enough opportunities to truly understand the underlying math and science skills afforded by the ROV. Egelston (1973) found students’ skills improved after participating in ten hands-on lessons.

Both Eddy and Marcia discussed the balance of allowing students the opportunity to explore and construct their knowledge compared to directly instructing students about specific facts. Toth et al., (2009) compared the sequence of providing students with virtual lab experiences and hands-on lab experiences. Their qualitative data indicated that the order of virtual and hands-on experiences mattered. Students who received the virtual treatment followed by the hands-on experience found the sequence to be very helpful. However, students who received the hands-on experience first did not find the virtual experience to be a valuable addition.

The many hands of a team. Much research suggested that group collaboration leads to better understanding of the concept or material as opposed to working independently (Johnson & Johnson, 2009). Corter et al. (2011) found "hands-on group data-collection condition creates more group cohesion and more efficient sharing of knowledge and goals, leading to better group work in subsequent data analysis and writing" (p. 2061).

The power of the groups was witnessed at both the elementary and secondary levels. At the elementary levels, many of the groups were based on previous relationships or friendships. At the secondary level, the students enrolled in the classes and were therefore required to work with the other students who enrolled. However, at the secondary levels sub-groups began to form based on interests and abilities. Some of the students preferred to work on the mechanical side of the project, whereas others were more inclined to put invest their time and energy into the presentations and marketing of their ROV company.

As teams faced challenges, the teams that worked together to overcome the obstacle did better than the groups where a single person tried to solve the problem. This, too, is reinforced by Corter et al. (2011), who noticed that, "group data collection is more effective than individual data collection for hands-on labs" (p. 2063).

By far, students prefer doing the hands-on components of the ROVs. Groups that did well with each other would take the time to share what Eddy described as the fun activities such as "cutting, drilling, soldering, attaching, and driving." Groups that struggled were groups where the members acted more on the behalf of the individual as opposed to the good of the team.

Will Jackson surmised, "It was the first time they were ever engaged in a team like activity." This should not be too surprising because cooperative learning or group work is often sacrificed in traditional classrooms to get through the assigned content. Quality teamwork requires people to be responsible for what Eddy Scintilla called the "secondary jobs." The secondary jobs may still be hands-on, such as managing the cords of the tether, but they are not at the same level as the pilot. Working in groups can be a complex mix of social rules and conditions, and ego, combined with the necessary tasks that need to be completed. Spending time working with students to debrief and analyze the group work and group dynamics would be beneficial. The *Project Adventure* W*hat Model,* as shown in a repeat of Figure 5*,* could be a powerful tool to use throughout the ROV experience.

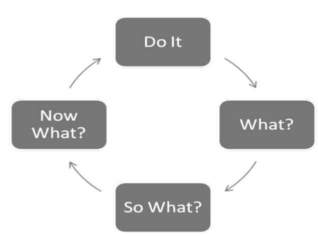

Figure 5. Project Adventure's *What* cycle.

Solving problems with hands-on learning. Project Adventure's *what model* fits very well into the project-based hands-on learning environment. The simple, yet complex cycle allows for familiarity, as it could be applied over and over again by not only the instructors, but also by the students. Spending the time working through this model could dramatically increase student success.

Much success in traditional schools is based on having the correct answer to a specific problem. For example, if a student has a geography test about United States capitols, he or she knows to memorize the states and their capitols. However, in project- based learning, the problem is often not defined in advance. For example, if the left propeller of the ROV is not working, there is not a ready apparent answer. However, understanding how to apply critical thinking or problem-solving skills students can, as Matt Fabo said, "find out some of the biggest problems are the simplest issues like a loose wire." Often students need to not only recall the information, but also to apply the knowledge under pressure.

During the pool mission at the Tawas event, the Legacy ROV suddenly lost power. The remote control would not respond. Kristine, the pilot at the time, immediately traced back the cords to the power source. She discovered the power cord to be disconnected from the terminals. She directed the rover to hold the wire to the terminal and the ROV resumed power. However, the polarity was reversed causing the control box to send the opposite signal to the motors. Again, Kristine needed to make another decision to overcome the newest problem faced in front of her. She made the decision to pilot the ROV using the reverse controls as opposed to having the rover disconnect and reconnect the wires to the terminals. As Matt said, having some basic knowledge helps, but the ability to thinking quickly on her feet allowed her to assess the problem. Again, debriefing with the *what model* could help reinforce not only the problem-solving exhibited by Kristine, but also to further explore the concept of polarity to the team and the rovers.

A hands-on problem-solving skill heard repeatedly from the participants was, “trial and error.” Roger Russell said, “trial and error is needed” in robotics. Multiple groups were witnessed using the trial and error problem-solving strategy as they attempted to achieve neutral buoyancy with their ROVs. Neutral buoyancy is when the ROV stays suspended in the water without sinking or rising. This is an important state to achieve because it allows the motors to work most efficiently. To achieve neutral buoyancy, students were adding or removing weight, foam, and capped pieces of PVC to their robots. They added or removed an item, then took it to the trough to see if it would sink, float, or stay suspended. Group members speculated on what to add or remove; they went with a convincing option and repeated until they achieved the desired outcome.

Critical thinking is a much more complicated process than providing a specific knowledge-based answer. Using a hands-on model within an active learning environment enhances problem-solving skills. Kern (2002) stated, “problem-solving in a hands-on environment allows students to see and think about their problem and solution in a concrete manner” (p. 251). This was helpful for students across the intellectual spectrum.

Perception

Perception is defined as a way of regarding, understanding, or interpreting something. Essentially, the schema or lens by which or through which a person perceives an event, activity, attribute, or trait filters or influences how it is understood. Just as an object viewed with the naked eye looks different when viewed through a microscopic or telescopic lens, so too can an event, activity, or attribute appear differently when viewed through the filter of perception. It is important to remember that the learners' perception is crucial. Martens, Bastiaens, and Kirschner (2007) stated, "The question is not if a task is authentic, interesting, or challenging, but whether it is perceived as such by students" (p. 83).

Our perception influences our thoughts, beliefs and actions; which in turn influences our self-perception and how we view the world around us. Harter (1999) stated that self-perceptions and perceived social regard play a critical role in how children feel and behave. Experiential education allows for adults and students to constantly analyze review, and explain our perceptions.

Gibbons, Ebbeck, Concepcion, and Kin-Kit (2010) analyzed an experiential education intervention that involved more than 1000 middle school students. They found "a very large effect with students in the treatment groups reporting significantly higher scores than students in the control groups on perceived social regard from classmates " (p. 797). They confirmed Hattie, Marsh, Neill, and Richards' (1997) perception of adventure education providing positive change to participants. Gibbons et al. believed that the format of experiential education "could explain the significant increase in perceived social acceptance" (p. 797).

Perception was also witnessed during the conduct of this case study. As an axial theme, perception cuts across many of the open themes such as confidence, teamwork, engagement, fun, time, communication, and problem-solving. The following subheadings provide specific examples of both student and adult perception.

Perceived confidence. Students involved with ROVs perceived themselves to be confident in their ability to design, build, navigate an ROV, and to be good team members. Chris Perez, along with Chip Diller, felt confident in their perception of providing good ideas, "to build and on how to drive the thing" to their groups.

As adults, Will Jackson and Matt Fabo perceived increased confidence in students' public speaking skills, especially as it came to interacting with adults. One of Jackson's highlights was being able to "See these kids in a completely different light." Will Jackson perceived an increase in student "confidence to be able to talk to me more like an adult to an adult." Fabo also commented students do not "seem to be apprehensive about speaking to an adult or speaking to someone of authority."

Marcia, too, perceived the students in the Scout ROV groups as "confident and happy about what they did almost the whole entire time." When trying to measure success of the program, she responded, "What I thought most telling was their confidence." Additionally, she noticed their confidence was not deterred by the "performance of their mission." Compared to what she sees in the classroom, Coach Marcia Ball was surprised by "how confident they were." Throughout the project, "They were very confident in everything that they were doing."

The adult perception of engagement. Student and adult engagement in ROVs was influenced by motivation, in particular tasks, and in the hands-on nature of experiential education. This section will focus predominately on two adults' perception of engagement.

Will Jackson spent time discussing his perception of a sub-group of students who do well with the uncertainty that is accompanied in project-based learning. This type of environment, although engaging, can be messy and chaotic. Some people do better with this level of uncertainty than others. Jackson made the following observation. "Kids that have a lot of experiences in their home and are encouraged to try new things get their hands on it and they do fine." Furthermore, "Kids that come from broken places and really chaotic environments seem to be OK with this. To them it seems to be if it breaks, it breaks, if it doesn't, it doesn't. They are not scared. They are not scared of failing. They dig their hands right in." Will acknowledged that this is not true for all kids who come from this environment, but stated, "I've noticed a group of kids that have a chaotic life don't get bummed out when something does not work." Will noticed the "group of them have embraced the idea that this is a part of life. You can work super, super hard and things may not work out." He noticed that students that have many life experiences and those from chaos seem to do better understanding "There are some unknowns and there are going to be experiences that they cannot control."

This concept is important to mention again because none of the at-risk students interviewed for this research perceived themselves to be at-risk of not finishing high school. Many of them came from environments as described by Will. Additionally, many of the students perceived their level of work and success during the ROV project as higher than their traditional classroom environments. It was also perceived by the coaches, teachers, and this researcher, that the students were engaged with the ROVs at such a deep level that inappropriate behavior was not an issue.

Perception of challenging the status quo. Marcia is a self-described "teacher of students." She made it a point not to identify herself as a grade-level or content-specific teacher. She is a veteran teacher with over 25years of experience. Her peers and supervisors perceived to be the type of person who is not afraid to share her opinion or state an unpopular position.

However, Marcia admitted that the perception of her peers had a strong influence on her instruction. It was clear that a deep part of Marcia believes that project-based learning engages students and helps them understand the content on a different level. She said, “I believe in my mind and heart that it is right.” But her instructional choices are influenced by her perception of how her peers would perceive her as a teacher. Marcia cited “the noise level as an issue.” She said, “I start to worry about what are they thinking on the other side of the wall? Is this too loud for (the next) room?” Marcia admitted, “I back off of keeping them (students) engaged because, even if you do have the activities and keep them engaged, there is the noise.” In many environments, the perception of students making noise equates to students not learning. Also, the perception of peer pressure has a tremendous influence over instructional choices. As Marcia said, “I start thinking about social norms and it's like, eww.”

ROVs perceived as fun. In many environments the dual perception of work being serious and play being fun is prevalent. Like many either/or perceptions, it is limiting and overly simplistic. A sense of enjoyment can actually create a more productive working environment (Ford & Heaton, 2000).

Chip Diller reinforced the perception that challenging work is fun, “I liked the struggle to get something to work; that was always fun.” Jesse Tanner had a similar perception, “I thought it was fun. It was challenging.”

Several celebrations of success were observed as the students worked in their groups. There were the obvious times, such as the successful completion of a mission, but also the joy described by both Chip and Jesse when students were able to solve a problem on their own. For example, a fourth-grade group was given the mission of picking up a simulated sea lamprey from the bottom of the pool. The lamprey had a metal band inside, and a group decided to use magnets to retrieve the lamprey. The idea was solid and it addressed a question posed earlier regarding whether magnets would work underwater. The group was excited about their design, and lifted the lamprey with the magnet ensuring that the magnet was indeed strong enough to lift the lamprey. They then placed their ROV in the feed trough, and went after the lamprey.

Suddenly the ROV went sideways and would not move any further. The propellers were spinning, but it would not move. The students went from confused, to angry, to laughter when they realized they were practicing in a metal feed trough, and the placement of their magnets kept drawing the ROV towards the side of the trough. The students laughed and then went back to work redesigning the placement of their manipulator on the ROV.

In addition to the perception of challenges being fun, it was also the students' perception that participating with ROVs solidified positive memories of the experience. Jesse Tanner: "When I got home I would still be thinking about that one class. Not really any others. I think it's because I had fun in that class." The perception of fun was again echoed by Chip Diller, "I can't remember every single lecture or can't remember every single test [from my English class], but in robotics, I can remember almost every step. It was because it was fun. It was enjoyable."

Not enough time. From observations and interviews, no person ever stated that too much time was given to a class, work session, or mission. The majority of the people perceived there was just not enough time. The teachers and coaches discussed how they needed more time to prepare not only materials but also lessons and communications. The students expressed hopes that the sessions could have been longer and also wished they had more time to compete in their missions.

A major obstacle of getting project-based learning in general and getting ROVs into classrooms, specifically, is the concern regarding time. Teachers believe that they cannot add another thing to their already busy daily schedule. Continuing to add more and more content in isolation is overwhelming, but when the content is integrated through projects, it is not as much about adding something else to a full plate as much as rearranging the order of the plate. For example, a plate that includes space for ham, bread, lettuce, a spot for cheese and another for mustard can appear full. However if it is stacked together you have a ham sandwich with even more room on your plate.

One of the biggest hurdles faced by Rebekah Waves when trying to recruit teachers is just getting them to open their minds about teaching differently, as opposed to “another thing.” She understands that “they only have so much time” and that they often feel as if “its overwhelming;” however, as findings of this study showed, student engagement increases, the time goes by quickly, and students are not only excited for the next session but also disappointed that the session ended.

Will Jackson faced this obstacle when he first brought the ROV concept to his peers; he noticed there were “a lot of worries about ‘How am I going to fit this in? How are we going to even manage it?’” Will did ROVs with his fourth-graders for a year by himself. The following year, it was the whole grade level. When Will switched grade levels, none of the remaining teachers continued with the ROVs. Some perceived that they were Will’s, and when he left, the ROVs left. Others again cited time. Will commented that he offered to have his peers come into his new room and use the materials; he even offered to have his students work with their students in a coaching role to help them be successful. Again, the perceived lack of time was the excuse given for not continuing to have the entire fourth-grade continue to have an ROV experience.

“There is not enough time” was stated almost as much as how fun it was to work with ROVs. There is a finite amount of time that is allotted for practice, instruction, competition, and work. It is impossible to create more time, therefore the only option that people truly have over capturing time is the management of time. Efficient and effective management of time is evaded for a host of reasons. This is not unique to adults and children working with ROVs. Seminars, books, classes, and consultation services focused on time management is, itself, an entire industry.

Time for skills. It takes time to improve skills, whether it is time to memorize multiplication facts or time to improve a solder. To get better at something, practice time is needed. Established institutional routines struggle with practice time, but because they are long established parts of the system, they are at least accepted. For example, many parents know that it is important that they spend time reading to and then with their child, for the current and future success of their child. Very rarely will parents articulate that they do not have the time to read with their child. Similarly students involved with sports accept they will need to practice their skills outside of the scheduled practice times with their coach. However, as a fledging program, most of the skill work related to ROVs took place at the schools. As a result, it was an increased demand on the already scarce amount of allotted time.

Independently both Marcia and one of her students cited the same example of time influencing them to take a shortcut. They both perceived that they just did not have enough time to do the task the correct way. Marcia's example involved a control box that had a wiring error. To fix the problem, she said, "They would have to open it up. We felt like there was not enough time to open it up and redo it." She was quick to add, "But really, they should have. Because they knew it was wrong; but we did not take the time. It would have been good to have time for them to redo it."

Similarly, Cal Naughton perceived the lack of time as the reason not to properly wire a motor. He said, "They were going to dry these tubes that tighten right on when the heat hits it. But, we never got done with it, so we just covered it with tape instead." He added, "We never really got time to finish it."

Both Marcia and Cal were candid in recognizing that they did not take the right steps and would do it differently in the future. When I spoke with Marcia and Eddy about the skill time, they both thought that having some station work time to improve skills, as well as developing an approval checklist before moving to the next step, would have been beneficial. Eddy emphasized that it was not that they did not think of this in advance, the problem became balancing the ideals with the reality. Again, time was a major culprit. Marcia and Eddy felt bad denying students the opportunity to go to the pool because they had such little pool time. However, they noticed that once they went to the pool, the groups that had problems were groups that took shortcuts. Eddy believed that the problem could have been avoided if the students had taken the time to ensure that they followed each of the steps in a pre-dive checklist.

I perceived that each of the adults that I interviewed gave considerable amounts of time to the ROV projects outside of their contractually defined instructional and planning time. It is important to note that when research was being conducted, each of the ROV groups were in their infancy. The ROV club at Legacy was in their first session, with both coaches a figurative step ahead of the students. Will Jackson and John Jameson had a bit more experience and flexibility in their schedule but all coaches were operating with loose coordination with each other and almost non-existent coordination or direction from district administration. If not for the passion and commitment of the individuals, it would have been easy to see the ROV program disappear over time.

Say what? One of the most telling examples of how perception is influenced by communication was from an ROV interaction at Dr. Jack Walton's center. He explained how a group of bilingual students, "which means probably half the students didn't speak English at all "were given a whole bunch of [ROV] buckets and a mission" to complete. The adults chaperoning the students told Walton that they never perceived "those kids as being very smart." To their chagrin, the students were able to build an ROV and complete the mission. Walton reflected that "it was a good reminder that these kids are actually [smart], they just don't speak English."

Communication between co-coaches Eddy Scintilla and Marcia Ball was a bit more complicated. Eddy and Marcia both shared candid stories about how they struggled to communicate with each other. When asked how the co-coaching roles went, Marcia responded, "It wasn't very smooth." Eddy agreed, "The communication between Marcia and I was challenging." It was Eddy's perception that, "Marcia and I did not communicate well."

As coaches working together for the first time, both Marcia and Eddy blamed the scarcity of time for their lack of communication. Marcia and Eddy would talk with each other on the days they traveled to West Arbor Hills for pool practice. From my conversations with them, it did not sound like long-term planning was taking place. I perceived that the conversations in the car were more reactive and casual, as opposed to deliberate and intentional discussion. Eddy reinforced my perception, "The small amount of time that we did get may not have been used as efficiently as it could have."

An idea to improve the efficiency of their small amount of time together might have been to maximize the commute time. For example, they could have intentionally planned the commute time as meeting time. One way to make this happen could have been creating a shared document with possible topics, questions, observations, and concerns. Both Eddy and Marcia could have added to the document throughout the week, and then the person not driving to West Arbor Hills could print the document and use it as a basis of conversation during the drive. To complete the cycle, upon return to Legacy, that person could have entered the information discussed into the document and thereby created a record for further reflection and planning. Eddy agreed the communication was not cyclic, "There was not a lot of follow up or conversation from week-to-week about how [things] should play out." The suggested document to guide commute-time conversation could have helped Eddy's desire to have "some planning time to prepare for the week."

Essentially this is an example of the same process cycle Henton (1996) described for adventure, but applied in a communication cycle. I believe this cycle would have been helpful not only for the coaches, but also for the team during this time. Again, the idea of non-linear process is important for ongoing reflection and improvement. It is often not the norm, but that is exactly why the cycle should be used.

Problem-solving. Life is a series of problem-solving events. From a hungry infant who learns that crying brings food, a tween trying to figure out how to get the attention of the girl in the second row, a college student deciding if he or she should buy or rent textbooks, to a senior making decisions about assisted living; problem-solving lies at the heart of perception. Perception is shaped by internal and external forces, many of which are emotional as opposed to rational, that unless one can understand the perception from which a person is viewing the problem and possible outcomes, misunderstanding and conflict may arise.

In many cases, problem-solving with ROVs required people to step back from the problem at hand and examine the problem from a different perspective. Or, as Matt Fabo said, focus on the “simple things.” Roger Russell found success in problem-solving by changing his perspective, this new way of thinking helped him “open my mind up and back away from the situation. See what's wrong and go from there.”

Another helpful change of perception is understanding that often there is more than one way to solve a problem. Many students have been conditioned to think that there is only a single answer. This is often true at a knowledge level of thinking; however, when trying to work your way through a problem, there can be many paths to the solution. This was seen over and over as students had to come up with solutions to solve a mission with their ROV. The outcome or answer is the same, such as remove the ring from the bottom of the pool, but coming up with how to remove the ring is where the multi-perspective lens comes into play.

Students who have shown success in a traditional school environment often struggled with the multiple perspective concept. Jameson shared several examples where students would become frustrated and ask, “What do you mean? How come you're letting him do that?” To which, Jameson would respond, “I didn't say he couldn't and I didn't say you couldn't. There's no set answer. Our job is to complete the mission or achieve the goal, not to follow a text and conform to what everyone else has already done. I don't mind if you look at what other people have done, if that's the best way to do it, that's fine. I'm not going to penalize somebody for doing it a different way if they achieve the same outcome or better.”

It is important for educators to provide opportunities for students to examine a problem from many perspectives. This can be done throughout the curriculum in a variety of ways. Keeping with the ROV theme, a teacher could create a writing or presentation activity requiring students to examine the BP Gulf spill from the perspective of an ROV pilot. The teacher could provide guiding prompts such as obstacles encountered and how the diver and her team overcame the obstacles. The instructor could pose math problems regarding the power and time needed to overcome currents and depth. Marcia said she "was surprised that the kids did not have more of those problem-solving or critical thinking skills," but in today's industrial model of education, students are rarely challenged with these types of activities.

Perspective matters. Perception influences how we see the world and create our reality. ROVs help students expand their perception by increasing their confidence in engaging activities that are fun. It is also important to be aware of the time needed to communicate in an effective manner to help solve problems.

Relevancy

As an undergraduate I was required to accumulate teacher-observation hours. I recall going back to a cherished sixth-grade teacher to inquire about observing her teach. Although I clearly remembered Mrs. O'Toole, I was not sure if she would remember me. I approached her classroom, reintroduced myself and waited a beat to see if my name jogged any memories. She smiled warmly, gave me a hug and stated that she not only remembered me but also had a specific memory that helped motivate her to be a better teacher.

Mrs. O'Toole told me about a warm spring afternoon when we were reading about explorers in the social studies textbook. She remembers that I raised my hand and asked, "Why we were reading this boring passage?" She shared that she was thinking the same thing, and the only answer she could come up with at the time was that it was in the textbook.

She recalled that although an honest answer, it was a terrible answer to be given by a teacher. She shared that as a teacher we need to find ways to make the curriculum relevant to the students and take responsibility for our lessons. She told me that when planning lessons, to always be able to answer, “Why are we doing this?” with a better answer than “it’s in the textbook.”

The concept of students believing that schoolwork is meaningful to their lives is known as academic relevancy. Andriessen, Phalet, and Lens (2006) stated that academic relevancy relates specifically to students’ experience of the academic material in their classes. Crumpton and Gregory (2011) wrote “academic relevancy is an understudied factor that may be protective for students with a history of low achievement” (p. 42). The relevancy of ROVs to students, especially at-risk students, was seen throughout this research. The axial coding of relevancy is built from the open themes of engagement, time, and problem-solving.

Relevant work is engaging. Each adult interviewed expressed sentiments regarding ROVs’ engaging students. John Jameson felt the ROVs “Gave them something to focus on. It made school relevant to them.” Coach Eddy Scintilla described students as “excited.” He also noticed, “Engaged students feel ownership and would not give up.” Part of this engagement was due to the fact that the students were creating and using real- time data to guide their work. They would make adjustments to their ROV based on the data they produced. Adams and Matsumoto’s (2011) research supported students using real-time data and stated it “not only adds relevancy to their learning experience but also engages students in scientific investigations” (p. 32).

Time became irrelevant. When students thought the work was engaging and relative for their current and future success, the specific time of learning became irrelevant. No longer was it math time or social studies time or even school time. Students became far less concerned about traditional boundaries of classroom and time of day; they become more concerned with academic relevancy. Academic relevancy is similar to Simons, Vansteenkiste, Lens, and Lacante's (2004) description of relevancy using the term *utility value*. Utility value is defined as the extent to which capabilities required for the present activity are similar to those capabilities required for a future task.

ROVs were not only in the present, but also often led to future tasks, many of which engaged students and changed how they used their time. Eddie shared, "I would hear from the kids' families that they are watching the History Channel and asking about ROVs. I would talk with parents at basketball games, and they would ask about ROVs. They would talk about the program and how they thought it was beneficial, and they were happy that it was at the school."

Tammy Blanchard added to Eddie's perceptions, "I'd go home and I'd look at like all of the designs and what they used for in real life." Furthermore, she would look at items around her home and wonder, "Can (I) use that to make an ROV?" According to Tammy, "I was just doing research on something and it was really cool."

Will Jackson cited a specific student, Judah, whom Will taught in a basic skill afterschool tutoring program. Will commented that Judah was "not engaged whatsoever in any of the afterschool tutoring." However, Judah became hooked with the ROV and "offers to come in before school or after school every single day of the week...even wanted to spend his recess time working."

Even at the high school level, some of Jameson's students gave up lunch with their friends to work on getting their ROV ready for the future. He stated, "Kids don't run out to lunch; they wait till the line goes down; they go out grab their lunch; they come back, and they program and eat at the same time at the computers." Further, Jameson said, "It drives (the lunch supervisor) nuts" when the students would leave the cafeteria to work on their robots. Several times Jameson had to tell her, "It's alright, just let them come back here; they are not hurting anything."

Solving relevant problems. The ability to solve problems is often considered to be one of the most complex intellectual abilities of humankind (Kwisthout (2012). Funke (1991) broke problem-solving down further into simple and complex problems using criteria like the transparency of the problem and solution definitions. Regardless of the type of problem, the perceived relevancy to current and future goals plays a dramatic role in student success Andriessen et al. (2006).

An example related to ROVs is that of a circuit. A complete circuit allows the ROVs to operate. One of the most frequent problems for teams to overcome was the loss of power. Students had to work through the power supply circuit to determine where the break occurred. When it comes to electricity and powering the ROVs, Matt Fabo stated that students "actually had to put the wiring together. They (needed to know) what is a circuit, a complete circuit, and a broken circuit."

From volunteers like Fabo to teachers like Jameson, each of the adults allowed students the opportunity to "make the mistake and then figure it out." Eddy stated that the problem-solving is not limited to the students. He spent "time on my own learning the content so I am comfortable. I also seek out others that have experience in that field. I can then learn from them, whether it is using their ideas, building on their ideas, or incorporating their ideas with what I already know or have learned myself." Seeking the skills to solve the problems of learning new content and supervising a group, Eddy applied the skills he asked of his students.

Marcia reflected on the manipulation and instruction of problem-solving skills. The students did not come with a strong skill set for problem-solving. She shared, "The teacher in me thinks that, really, I should have probably spent more time on how to problem-solve, how to get along with other people, how to design things. Get them working together, show them how to think about solutions to a problem. What to do when something does not work."

Chances are, talking about these skills in isolation would have been nowhere near as powerful if she had followed the Project Adventure *What Cycle* and led the students through a debriefing of specific behavior. This could have been very relevant for technical problem-solving and problem-solving social dynamics. The path taken was the traditional linear path; a change in direction may have made a large impact on the individuals and the groups.

A relevant model. Crumpton and Gregory (2011) put forward the model shown in Figure 9 that demonstrated the relationship of academic relevancy toward motivation and achievement. Crumpton and Gregory explained, "The more students find school relevant, the more they may be intrinsically motivated to be engaged in class and more academically successful in their coursework" (p. 45).

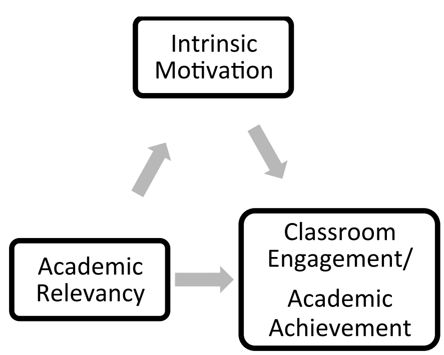

Figure 9. Academic relevancy model.

Relevancy can vary depending on the learner and the stage of the learner's learning cycle. It is important to remember that the relevancy is from the perspective of the student. The teacher can help make the content relevant by expanding beyond "it's in the textbook" for an explanation of study.

The four crosscutting themes at the heart of this study led to the summary of conclusions: Student *Motivatio*n was impacted by *Hands-On Learn*ing that was *Perceived* to be *Relevan*t. Those themes are addressed in the following section of implications for theory, research, practice, and the professional development of the researcher.

Implications for Theory

Motivation. Nicholls (1984) stated that people attempt to demonstrate achievement behavior through either task involvement or ego involvement. Throughout the ROV experience, students and adults were motivated by both task and ego, not usually an either/or choice. Instead, it appears to be more of a continuum based on a variety of factors such as personal responsibility, confidence, and engagement.

The nature of designing, building, and executing a mission with an ROV is heavy on tasks. Tasks provided students the opportunity to set aside the labels generally accumulated from ego and focus on specific success-defining tasks. Nicholls (1984) asserted that people select tasks to maximize the demonstration of high ability and avoid those tasks that would show low ability. Although generally true, in this study, this was not always the case. Soldering was an example. None of the students in the Legacy ROV group had experience soldering. However, students and adults alike attested to the students' willingness to show their low ability as they attempted to solder wires on their ROV. The dynamics and needs of the group often placed people in the position of expressing their vulnerability, as they sought help to acquire new skills or overcome a challenge.

A strong task environment increases intrinsic goal orientation. Tasks help students engage in activities based on traits such as curiosity, task challenge, and improving or perfecting of mastery (Amabile et al., 1994; Gottfried 1990; Nicholls, 1984). At both the elementary and secondary levels students were observed solving problems on their own or within their groups without relying on the teacher or coach to provide the correct answer. When students were given autonomy for their learning, their intrinsic goal orientation increased.

The ROV experience created many opportunities for task involvement. The influences of an ego-involved system are still present, but participants were willing to take risks if they felt part of a team and were engaged in fun, relevant tasks. Although there was competition in ROVs, values often associated with intrinsic goal orientation were present during this study. The extrinsic motivation of winning the competition was not the dominant motivator for the participants involved in the experience.

Adventure education. When people think of adventure education, it is usually in conjunction with such outdoor pursuits as high-ropes courses or backcountry adventures. One reason adventure education theory is powerful is the engaging nature of adventure. In many cases, it is not only hands-on, but also often full-body. The sense of risk often draws people to equate adventure education exclusively with adrenaline-pumping outdoor pursuits. However, the essence of adventure education is an engaging hands-on experience.

Horwood (1999) defined five characteristics that qualify an activity as adventurous: uncertain outcome, risk, inescapable consequences, energetic action, and willing participation. Although Horwood's criteria for adventure education are important, The essence of the ROV adventure experience was the uncertain outcome and inescapable consequences.

Students and adults were uncertain of the outcome during the entire ROV experience. Students in Springfield never heard of an underwater ROV or had an idea on how to successfully create and operate the device. However, a true sense of adventure emerged as they were given a brief explanation, materials, and an objective with no guarantee of success or a single correct answer. Students could not escape the consequences of their actions. When they put the ROV in the water, it would either sink or float. If they properly wired the motors, the device would respond as commanded. Even if the device responded, it still took skill and practice to pilot the device to complete the missions.

When Will Jackson first brought the idea of ROVs to Springfield schools, he was uncertain whether he could obtain funding to secure the materials, unsure of where and how he would be able to get access to water for his students, and uncertain of how his peers would respond to the unit of study. Eddy and Marcia were uncertain of how to form a ROV club or how to prepare for a regional competition. John Jameson was uncertain of how he would get his students to an international competition and maintain a resource- intensive program at the high school. The ROV experience at Springfield Public Schools was truly a form of adventure education.

Kolb's learning cycle. Kolb's (1984) learning cycle can help facilitators and participants understand many perspectives into learning. It is helpful in understanding learning styles or preferences and the cycle of experiential education, which demonstrates that concrete experiences lead to observations and reflections. These reflections are converted into abstract concepts, which lead to an action, which can lead to active testing and experimentation, which leads to the creation of new experiences. Kolb's image of the complete cycle, shown in Chapter Two as Figure 4, is repeated here as an aid to the discussion of learning styles.

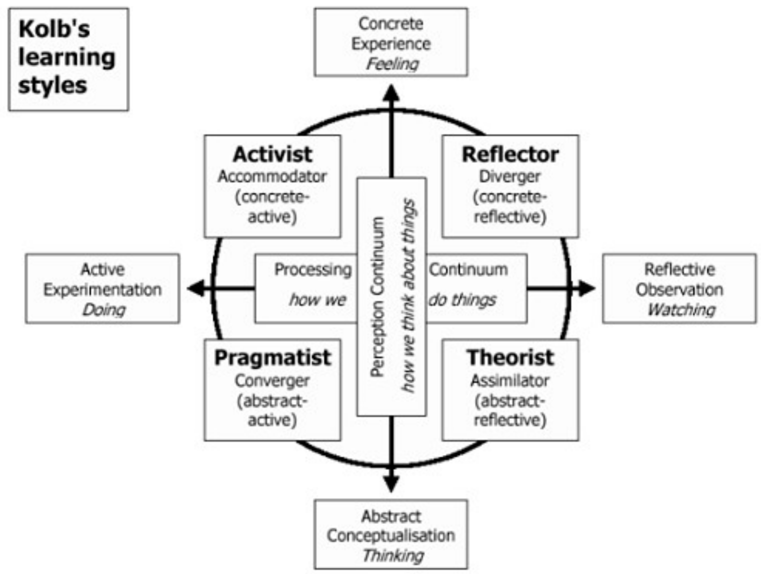

Figure 4. Kolb's (1984) learning styles.

I found the emphasis in various quadrants of the model was rarely equal. People wanted to stay in a quadrant in which they were comfortable. Individuals tended to work through a hemisphere as opposed to the whole cycle. For example, the Ninja ROV group at Legacy would often stay in the top hemisphere when trying to get their ROV to float. They conducted "trial and error" based on a feeling. If the ROV not floating properly, one student may have thought the solution was to drill some holes in the frame. A member would start drilling holes. The ROV would get thrown back in the trough, and the group would see what happened.

The concrete experience was to drill holes and see if it would float. The students moved across the process continuum from active experimentation of drilling holes wherever it looked good to the reflective side by observing if the ROV sank or float.

Kolb's (1984) learning cycle is a valuable tool for learning and reflection. Instructors and students could benefit from deliberate time spent on the explanation and application of the cycle. Emphasis does not need to be spent on the successful use of the entire cycle, but instead on understanding how users move throughout different parts of the cycle and continuum depending on circumstances.

Existing theories regarding motivation, adventure education and learning cycles all attributed to this research. This research also highlighted areas within the theories that were examined for additional emphasis upon application. When students and adults felt responsible and a valuable part of a team they were motivated by both task and ego. The ROV experience is a powerful form of adventure education. Uncertain outcome and inescapable consequences are at the center of the ROV adventure. Adults and students should follow through Kolb's (1984) learning cycle and continuum, as this metacognition will help improve teamwork and improve an understanding of how to work through a process.

Implications for Research

Initially I was attracted to the idea of a land-locked school that offered learning opportunities focused on the marine environment because it seemed so incongruous. Underwater exploration was not part of the Springfield culture. Many of the students have not been to a Great Lake, let alone an ocean. This qualitative research about a specific story may not be statistically transferable; however, further quantitative research could be conducted based on the transferability of the findings and conclusions from this research project.

Further research on motivation through experiential education could reinforce Shavinia's (2008) examination of internal characteristics such as persistence, the ability to learn from mistakes, and the resilience to keep trying despite initial setbacks. Shavinia examined these characteristics in vocational learning environments. Clow and Haight (2007) further examined these characteristics, as they hypothesized that vocational talent is more multi-faceted than traditional academic ability. My research provided examples of at-risk students performing differently in the experiential education environment than in the traditional school environment.

The literature supported the need for intentional reflection on learning. There was a lack of explicit reflection at Springfield. Explicit reflection is a variable that could be controlled. An extension of this research may determine whether there is a measurable difference in student learning based on reflection. Furthermore, I found it interesting that not a single at-risk student identified himself or herself as being at-risk of not graduating from high school. Was this unique to the population selected? Is this an undiscovered trait of at-risk students? Further self-efficacy research into at-risk students engaged in experiential education is warranted.

Another implication for research following this study may be in the development of a lab school, a form of experiential education involving higher education and K-12 education. Research and application of experiential education experiences could build towards creating a more clinical approach of research. A clinical approach is designed to overlap the role of researcher with the practitioner. Clinical-based research could make educational research more relevant for practitioners. Bulterman-Bos (2008) compared medical clinical research to educational research. They built upon the success of integrated practice and research in the medical field and discussed ways in which clinical studies can integrate the wisdom of practice with the findings of research in the educational field. This is not a new concept; it is reminiscent of the laboratory schools established by such researchers as Dewey (1938).

Further research into the transferability of motivation, hands-on learning, perception, and relevance within experiential education is recommended. The skill and ability to build reflection into the learning process should not be an afterthought. A comparative study of tasks with the variable of deliberate reflection would be an interesting area for further research. Research done within a school setting in a clinical- based environment could have a powerful impact on narrowing the gulf between practitioners and researchers.

Implications for Practice

Ego- to task-based structure. The American school system is very ego-based. Students are categorized and separated based on tests, grades, and labels. This research demonstrated the power of task-based learning. When students were presented with specific tasks as a measurement of success, they were motivated to learn in atypical ways. There were many occasions when students and adults still reverted to the ego-based structure on which they were familiar. However, if we are deliberate and intentional, we can change the format and create a better learning environment.

The themes identified from this research are not profound or revolutionary; they are desirable characteristics that often exist in many learning spaces. What is unique is the impact experiential education can have on producing a climate that allows these themes to be sustained and prevalent. Clearly these themes did not happen all of the time in Springfield, but when they did take place, the environment was much different than the traditional learning environment.

Task-based learning can produce specific measurable objectives that help students judge their success on completing the task. Confidence increased as students overcame obstacles and experienced success creating and operating an ROV and presenting their accomplishments. Students were engaged throughout the process, especially with specific tasks. Students enjoyed the autonomy of choosing teams and assuming responsibilities within the team. The importance of being a responsible member of a team was reinforced when adults and students alike had specific roles and responsibilities. Again, the specific roles and tasks allowed the focus to be on the work and not on the person. It also allowed for a variety of personalities to experience success and engagement.

Time was always scarce. It is important to be deliberate with the time given. The need for open and honest communication is important for teachers or coaches who are working together on a project. The communication norms need to not only be established in the beginning of the experience, but also applied as a cycle throughout the experience. This idea of a cycle is again reinforced by the theme of problem-solving. Students mainly demonstrated success through a series of trial and error endeavors. Students participated in a higher level of thinking when they had real problems to solve. Success required them to think and apply knowledge to find a solution, as opposed to just reciting facts. The process could be improved through the use of a debriefing and problem- solving cycle.

Experiential learning cycle. The experiential learning cycle can easily be applied to the work with ROVs, as seen in Figure 3, which is repeated from Chapter Two. Due to the nature of ROVs, the cycle almost happened by default. However, the deliberate and explicit use of the cycle was lacking.

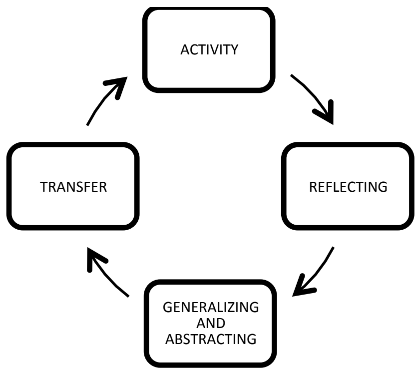

Figure 3. Experiential learning cycle.

I do not believe there is a philosophical or pedagogical belief against the cycle. Instead, I believe our culture has a very linear thought process and therefore a linear model of instruction has surrounded education.

Figure 10. Linear model of instruction.

This model does not place an emphasis on reflection or process. Instead the emphasis is on production, similar to the assembly line or industrial model. Even though the model may repeat itself, it is not cyclic due to the fact that there is not a need to reflect or transfer learning from one task to the next task. Successful experiential education learning is very process-orientated, it is "a way of doing; not something that you do" (Project Adventure, 2013).

Reflection is an important component of experiential education. Scaffolding the experiential learning cycle is recommended, in which instructors by start with the *Project Adventure What Cycle,* then move to the experiential learning cycle, and finally to Kolb's (1984) learning styles model. Like most instructional models, it would be best to start the intentional and explicit use of the models as a teacher-led exercise, expand into groups, and then to individuals. Displaying the cycle throughout the learning environment could also serve as a reminder of using the process throughout the experience.

Professional development. All of the teachers and coaches involved with the ROV projects at Springfield shared that they felt ill-prepared to instruct in a project-based environment. Eddy, Marcia, Will, and John each attended different private and public K-12 institutions and different universities. Will taught in a different school district before coming to Springfield. All are dedicated professionals, and for each, the ROV program was a different way of teaching than the way they were taught in school or trained in college.

The additional training received by the instructors focused on ROV specifics rather than methods or pedagogy. Providing opportunities for professional development would be a strong implication for practice. In particular, becoming part of a professional learning community that educates and helps hold each other accountable would be a better use of resources than a *sit and get* professional development session. The Buck Institute of Education (BIE) offers one example of a professional development opportunity through access to live webinars, Google Hangouts, Twitter chats, online classes, and conferences (Buck Institute of Education, 2014).

Make learning an adventure. An important conclusion of this study held that Hands-on learning perceived to be relevant impacted student motivation. This is not limited to ROVs or the great outdoors. As teachers examine their curriculum in the future, it would be wise to build for adventure in the classroom. Prouty's (2007) definition of adventure education as, "direct, active, and engaging learning experiences that involve the whole person and have real consequences" (p. 12) should be a guide for lesson planning and assessments. As students and adults have an adventure learning, curriculum becomes more about "a way of doing; not something that you do" (Project Adventure, 2013).

The school environment places a premium on practical applications of research. We can improve learning by emphasizing a task-based structure that relies less upon social comparison. The comparison should take place within the learning cycle as students reflect on the skills and knowledge acquired in one task and transfer them to the next. Again, the deliberate use of a cycle is recommended. Deliberate professional development for not only the tasks, but also the experiential learning process would help teachers instruct in a manner that is less linear and industrial.

Implications for My Professional Development

By nature I am quantitative in my thinking and decision-making process. I prefer to look at unemotional data and make a decision based on the information. Following a logical pattern or formula is comforting and makes sense to me. It was easy for me to quickly gather and process data, make a decision, and feel confident it was correct.

Originally I anticipated a quantitative design for my research. However, as I was designing my prospectus I began to contemplate qualitative research. I thought qualitative research would challenge me as a professional and be the best mode to research and tell the story of the ROV experience at Springfield. Throughout the process, I often wondered if I made the correct decision.

Many times throughout this process I felt it would have been easier and more efficient if I had conduced quantitative research. I found the qualitative process to be inefficient and out of my control. These are characteristics that make me uncomfortable. I am used to being efficient with my time, words, actions, and thoughts. While conducting this research, I spent an incredible amount of time observing, listening, and thinking. I thought about possible motives and all of the moving parts that were taking place within a scenario. I lived in the gray fog of data trying to find themes and patterns. I found that often there was not a universal correct answer, but instead, the best answer for that point in time. Finally, I gave myself over to a process and tried not to focus as much on the product. I had to trust the experience to guide me. This was a challenge and also a reward.

I believe I have grown personally and professionally by committing to the challenge of conducting a qualitative research project. In particular, my thinking and outlook of the world has changed. I now find myself spending more time thinking and less time acting. This has caused some conflict for me because I still find myself judging success by outcomes and efficiency. But, I have become more comfortable accepting the marathon point of view as opposed to the sprint.

During my coursework, professors (and students further along in their program) would often say that the easier part of the program was the scheduled classes. They said that the independent research and writing was much tougher. As a father and husband working a full time job and taking classes, I thought they were clearly exaggerating. I assumed they were either trying to motivate us to do well in our coursework or perhaps enhancing their own bravado or self-importance. I could not imagine how the dissertation could be that much harder.

I think that what is harder is the independence. You really have to be an independent worker to complete this project. There is no prescribed class schedule or syllabus. Classes have a set start and end time, specific assignments, and for the most part, clear requirements. During a class, a familiar routine sets in. You know who sits in certain parts of the classroom, you get to know a classmate's perspective and point of view on a topic, you know the expectations of the professor, and there is a pulse to the class.

The numerous dissertations I encountered during my research had some similarities in formatting and structure; however, the qualitative dissertations were extremely diverse, reinforcing again the idea that there was no one correct answer or format. This often left me feeling adrift, frustrated to not know where I was going. I had to trust the process and go where the data took me. I also felt much more alone in this process than a class. The writer is alone during the dissertation phase. In my case, my chair, Dr. Anderson, was the only link I had to the institution. Access to the university library was just a portal; all of the databases are electronic so there was no need to physically be on campus. Due to geography, I spent more time at Michigan State University's main campus library than I ever did at the Eastern Michigan University library.

In my personal and professional circles, there are no other doctors of education or philosophy. Thus, I had no one with whom to share common experiences and commiserate or celebrate. Fortunately two people from my cohort checked in with me and offered words of encouragement. Overall, I was alone with my thoughts and predominantly concerned that I had invested too much time, effort, money, and countless other sacrifices to walk away *ABD.*

I constantly juggled the many balls that life throws at a person. If I was not at my computer directly working on this dissertation, it was always on my mind. There was not a single day that went by that I was not thinking about this project. Many times I was discouraged when I did not meet an arbitrary deadline I set for myself. I revised the goal and set another deadline. Like a finding of my research, the more task specific, the better my motivation.

I mastered the qualitative process and taught myself how to use several pieces of software to conduct my research and write this paper. It started with a way to store references. Initially I learned how to use *RefWorks* to collect and organize my references. The University cancelled their subscription to this software, so I had to find another way to organize. I then taught myself how to use *Zotero*. Although I do not think I used either piece of software to their full potential, I found both pieces to be extremely helpful in organizing and tracking references.

I was paranoid about losing my work and decided that *Dropbox* would be a great solution for backing up my compositions. Dropbox allowed me to toil at my main laptop and sync my folders and files to my secondary laptop and to the cloud. It is all password-protected and secure and made me feel much more comfortable when I significantly reduced the possibility of losing this dissertation and corresponding materials. Even so, I still backed up my files to an external hard drive.

AudioNote was downloaded to my iPad and laptop to record my interviews and functioned as a field journal. The software afforded a place to transcribe interviews. I again used Dropbox to create a shared a folder with a transcriptionist allowing for increased efficiency.

I used *XMind* for mind mapping. In the past I usually used a spreadsheet to organize my thoughts, but XMind became the go-to tool for me throughout the process. I was constantly using XMind to organize thoughts, interviews, analysis, themes, and chapters. Dropbox worked mainly in the background, and XMind in the forefront.

Finally, I used *Dedoose*, a secure online piece of software designed for qualitative analysis. Dedoose was intuitive and provided a great way to code and reduce data. It allowed me to code my material and find patterns and connections from the mounds of collected data. I was able to set up my account, use it from any location, and only Dr. Anderson and I had access.

I have always been self-motivated and like to integrate technology into my life. Discovering and learning to use the various applications did take a fair amount of time, but each piece of software helped in numerous ways to use resources more efficiently. With the exception of Dedoose, I have transferred the use of the acquired software into other aspects of my life.

Throughout this dissertation experience, I have found that my perspective has constantly changed. I am able to examine a scenario from multiple perspectives from the macro through the micro level. I better understand multiple points of view and deciphering the motivation behind an action.

A professor in one of my classes used the book *Zoom* by Istvan Banyai (1998) to reinforce the power of perspective. I have continued to use the book during staff development and student trainings. Working through this dissertation, I often practiced zooming in and out, trying to understand how everything fits together. The level of focus and the point of view has a tremendous influence on our perception of what is (and is not) taking place within a particular situation. Helping people understand what is taking place from multiple perspectives is the experience of education.

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Appendices

Appendix A: Student Interview Protocol

Consent Form and Introduction to the Interview
Review the consent form with the participant lending particular emphasis to the following:

- My role as a researcher, purpose of the study, voluntary nature of their participation, time commitment, how the interview will be used and by whom, audio recording, reminder that they may be contacted for future interviews.

Learning about the Individual and their Educational Experiences

- Please introduce yourself (grade/age).
- Tell me about yourself (your family, where you grew up, what you like to do for fun).
- What do you think of school?
- What do you like about school?
- What do you dislike about school?
- How do you think you do in school?
- How would you describe yourself to someone else?
- Do you consider yourself "at-risk" of not graduating high school?

ROVs and Learning

- What do you think of your experiences with ROVs?
- How does it compare to other things you do in school?
- What have you learned while working with ROVs?
- What have you done to help your team?
- What has been hardest for your team?
- What has been most difficult for you?
- What has been your team's biggest success?
- What has been your most memorable experience?
- What would you change about your ROV experience?
- What would you change about school?
- Would you enroll in a similar club?
- Would you take a class based on projects such as ROVs?
- What suggestions might you have for someone considering joining a ROV team?
- Is there anything else you would like me to know regarding your learning experiences?

Appendix B: Instructor Interview Protocol

Consent Form and Introduction to the Interview

Review the consent form with the participant lending particular emphasis to the following:

- My role as a researcher, purpose of the study, voluntary nature of their participation, time commitment, how the interview will be used and by whom, audio recording, reminder that they may be contacted for future interviews.

Learning about the Individual and their Educational Experiences

- Please introduce yourself (grade/age).
- Tell me about yourself (your family, where you grew up, what you like to do for fun).
- How is working with ROVs similar to what takes place in your classroom?
- How is it different?
- Did you receive instruction like ROV projects as a student?
- What kind of student were you in school?
- How would you describe yourself to someone else?

ROVs and Learning

- How did the students respond?
- What surprised you most about the teams?
- What have you learned while working with ROVs?
- What would you improve upon for the future?
- What will you leave the same?
- What has been most difficult for you?
- What has been the greatest challenge of working with the ROV group?
- What has been your biggest success?
- Did you notice a difference between the "at-risk" students and those not considered at-risk?
- What has been your most memorable experience?
- What would you change about your ROV experience?
- What would you change about school?
- Would you lead in a similar club?
- Would you incorporate more projects such as ROVs in your classroom?
- What suggestions might you have for someone considering leading a ROV team?
- Is there anything else you would like me to know regarding your learning experiences?

Appendix C: Family Interview Protocol

Consent Form and Introduction to the Interview
Review the consent form with the participant lending particular emphasis to the following:

- My role as a researcher, purpose of the study, voluntary nature of their participation, time commitment, how the interview will be used and by whom, audio recording, reminder that they may be contacted for future interviews.

Learning about the Individual and their Educational Experiences

- Please introduce yourself.
- What is your relationship to _____________?
- Tell me about yourself (your family, where you grew up, what you like to do for fun).
- What do you think of school?
- How do you think ___________ views school?
- What do you like about school?
- What do you dislike about school?
- How do you think _____________does in school?
- How would you describe yourself to someone else?
- How would you describe ____________ to someone else?
- Do you consider _____________ "at-risk" of not graduating high school?

ROVs and Learning

- What has ______________ shared with you about his/her experience in the ROV club?
- How does it compare to other things he/she does in school?
- Would you enroll him/her in a similar club?

School Experience

___________________has always attended school at BCS?

I like the schools my child has attended.
Disagree Strongly Disagree Neutral Agree Agree Strongly

I like the teachers of the schools my child has attended over the years.
Disagree Strongly Disagree Neutral Agree Agree Strongly

My child has been treated fairly with matters related to school discipline.
Disagree Strongly Disagree Neutral Agree Agree Strongly

My child was helped by a school social worker, counselor or other school personnel throughout school.
Disagree Strongly Disagree Neutral Agree Agree Strongly

My child was often misunderstood in school.
Disagree Strongly Disagree Neutral Agree Agree Strongly

My child was suspended from school a lot because he/she misbehaved in school.
Disagree Strongly Disagree Neutral Agree Agree Strongly

Teachers tried to prevent my child from getting into trouble.
Disagree Strongly Disagree Neutral Agree Agree Strongly

My child's schools code of conduct was enforced fairly.
Disagree Strongly Disagree Neutral Agree Agree Strongly

My child had difficulty making good decisions.
Disagree Strongly Disagree Neutral Agree Agree Strongly

My child's teachers and principals understand the community in which I raised my child.
Disagree Strongly Disagree Neutral Agree Agree Strongly

The teachers at my child's schools respect all students and their backgrounds.
Disagree Strongly Disagree Neutral Agree Agree Strongly

I feel that my child's teachers took cared if my son/daughter failed academically.
Disagree Strongly Disagree Neutral Agree Agree Strongly

I feel that my child is in trouble a lot.
Disagree Strongly Disagree Neutral Agree Agree Strongly

My child can confide in me when he/she needs help.
Disagree Strongly Disagree Neutral Agree Agree Strongly

I can make a difference in my child's education.
Disagree Strongly Disagree Neutral Agree Agree Strongly

I can go to the school and easily speak with the teachers and principals about my child's education.
Disagree Strongly Disagree Neutral Agree Agree Strongly

If I could change one aspect my child's school experience it would be: ____

____

____

If I could keep one aspect of my child's school experience the same it would be: ____

____

____

Is there anything else you would like me to know regarding ___________ learning experiences?

Appendix D: Individual Interview Protocol

Consent Form and Introduction to the Interview

Review the consent form with the participant lending particular emphasis to the following:

- My role as a researcher, purpose of the study, voluntary nature of their participation, time commitment, how the interview will be used and by whom, audio recording, reminder that they may be contacted for future interviews.

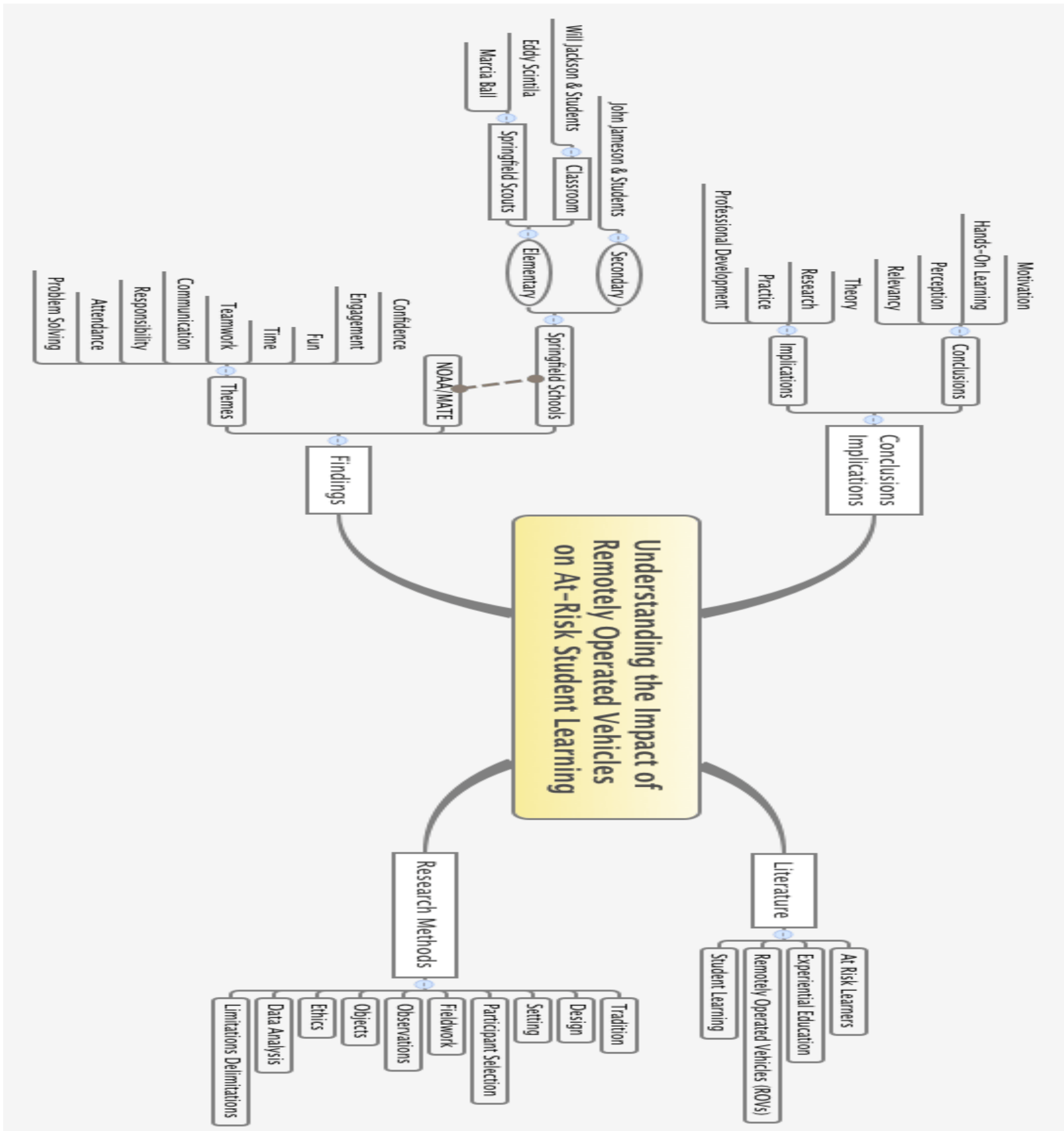
Learning about the Individual and their Educational Experiences

- Please introduce yourself (grade/age).
- Tell me about yourself (your family, where you grew up, what you like to do for fun).
- How did you become involved with ROVs?
- Did you receive instruction like ROV projects as a student?
- What kind of student were you in school?
- How would you describe yourself to someone else?

ROVs and Learning

- Tell me about your experiences utilizing ROVs.
- What has been the reaction of others, not in the field, when you explained your involvement with ROVs?
- How many groups/people have your provide support or assistance as they introduce ROVs to students?
- What has been one of your biggest obstacles to overcome?
- What age group have you worked with?
- Is there an optimum age group?
- What changes have you noticed regarding ROVs and education?
- What impact have ROVs had on student learning?
- What surprised you most about the teams?
- What have you learned while working with ROVs?
- What has been the greatest challenge of working with the ROV group?
- What has been your biggest success?
- Did you notice a difference between the “at-risk” students and those not considered at-risk?
- What has been your most memorable experience?
- What would you change about your ROV experience?
- What would you change about school?
- Would you lead in a similar club?
- What suggestions might you have for someone considering leading a ROV team?
- Where would you like to see ROVs and student learning in the next 10 years?
- Is there anything else you would like me to know regarding your learning experiences?

Appendix E: Concept Map



Appendix F: Approval By University Human Subjects Review Committee

EASTERN MICHIGAN UNIVERSITY EDUCATION FIRST

University Human Subjects Review Committee · Eastern Michigan University · 200 Boone Hall
Ypsilanti, Michigan 48197
Phone: 734.487.0042 Fax: 734.487.0050
E-mail: human.subjects@emich.edu
www.ord.emich.edu (see Federal Compliance)
The EMU UHSRC complies with the Title 45 Code of Federal Regulations part 46 (45 CFR 46) under FWA00000050.
UHSRC Initial April 18, 2012 Application Determination

EXPEDITED APPROVAL
To: James Kelly
Educational Leadership and Counseling
Re: **UHSRC #120314** Category: Approved Expedited Research Project
Approval Date: April 10, 2012
Title: Enhancing Professional Profiles: Understanding the Impact of Service Learning in Higher Education
The Eastern Michigan University Human Subjects Review Committee (UHSRC) has completed their review of your project. I am pleased to advise you that **your expedited research has been approved** in accordance with federal regulations.
Renewals: Expedited protocols need to be renewed annually. If the project is continuing, please submit the **Human Subjects Continuation Form** prior to the approval expiration. If the project is completed, please submit the **Human Subjects Study Completion Form** (both forms are found on the UHSRC website).
Revisions: Expedited protocols do require revisions. If changes are made to a protocol, please submit a **Human Subjects Minor Modification Form** or new **Human Subjects Approval Request Form** (if major changes) for review (see UHSRC website for forms).
Problems: If issues should arise during the conduct of the research, such as unanticipated problems, adverse events, or any problem that may increase the risk to human subjects and change the category of review, notify the UHSRC office within 24 hours. Any complaints from participants regarding the risk and benefits of the project must be reported to the UHSRC.
Follow-up: If your expedited research project is not completed and closed after three years, the UHSRC office will require a new **Human Subjects Approval Request Form** prior to approving a continuation beyond three years.
Please use the UHSRC number listed above on any forms submitted that relate to this project, or on any correspondence with the UHSRC office.
Good luck in your research. If we can be of further assistance, please contact us at 734-487-0042 or via e-mail at human.subjects@emich.edu. Thank you for your cooperation.

Sincerely,
Deb de Laski-Smith, Ph.D.
Interim Dean
Graduate School
Administrative Co-Chair, University Human Subjects Review Committee

Appendix G: Informed Consent

Using Remotely Operated Vehicles to Improve Student Learning
Informed Consent for Participation in Individual Interview

Introduction and Purpose of the Research. I volunteer to participate in a research study, which is conducted by James E. Kelly a researcher from Eastern Michigan University. I understand that the purpose of this project is to examine the impact of Remotely Operated Vehicles (ROVs) on student learning.

Procedure Participation involves being voluntarily interviewed by the researcher. Each individual interview will last approximately 60 minutes. The researcher may request follow-up interviews. These follow-up interviews are intended to allow time for you to elaborate and clarify information from the initial interview. I understand the researcher may wish to contact me in the future via phone, email or in person in order to clarify or summarize statements made during the individual interview process.

I understand that I will be asked questions about my educational experiences. I have the right to decline to answer any question or to discontinue participation at any time.

I voluntarily agree to be audio recorded during each of the interviews. I understand that some of the audio files will be transcribed and that the audio file and the transcripts will be used exclusively for the purpose of this study. The audio and text files will be securely stored on the researcher's password-protected computer. Paper copies will be stored in a locked cabinet.

I understand that the interviews will be transcribed by the researcher or a professional transcription service. The transcribed documents will utilize pseudonyms in order to protect the identity of participants. The transcribed documents will be stored on the researchers password protected computer and in a locked cabinet.

Voluntary Participation My participation in this study is voluntary and I may withdraw or discontinue participation at any time without penalty or loss of benefits. I understand that there is no penalty to me should I decide to withdraw from the study. I understand that my continued participation in the study is based on my willingness.

Confidentiality I understand that the researcher will not identify me by name in any reports or articles using information obtained from this interview. My confidentiality as a participant in this study will remain secure through the assignment of a pseudonym. A separate list matching participants' names with their pseudonym will be stored on the researchers password protected computer and in a locked cabinet. All information collected will remain confidential except as may be required by law.

My confidentiality as a participant of the study will remain secure through this dissertation through the use of a pseudonym. Pseudonyms will be used for the actual names of participants, places, and events. The use of a pseudonym is designed to protect the confidentiality of the individual. I understand that the researcher will not identify me by name in the dissertation or publications using information obtained from this interview. I understand although pseudonyms will be used for the actual names of participants, places, and events there is some risk of recognition by future readers or audiences. All information collected is designed to protect the confidentiality of the individual. All information collected will remain confidential except as required by law.

Expected Risks I understand that participating in this study there is less than minimal risk. The less than minimal risk would not be over and above that ordinarily encountered in daily life. While there should be less than minimal risk to you in participating in this study, there is the possibility that as you respond to questions you may feel some distress through identifying experiences from your own past.

Expected Benefits Although I may not receive direct benefit from my participation, my participation in this study may offer the opportunity to consider and articulate, without restriction, my experiences and perceptions. Furthermore, others may ultimately benefit from the knowledge obtained in this study.

Use of Research Results The results from this dissertation research may be reported in the professional presentations, and other professional reports and publications (i.e. journal articles). In any and all of these future disseminations pseudonyms for actual names of participants, people, places, and events will be used to protect the confidentiality of the individual. The intent is to give an accurate account of your experience.

Please check the boxes below to indicate participation.

_____ I have been given a copy of this consent form.

_____ I have read and understand the above explanation provided to me.

_____ I have had all my questions answered to my satisfaction, and I voluntarily agree to participate in this study.

_____I willingly agree and authorize to be audio recorded for this research.

Please sign below if you are willing to participate in this study:

____
Participant's Signature

____ Date ____________________
Participant's Name (printed)

____ ____________________
Interviewer's Signature Date

This research protocol and informed consent document has been reviewed and approved by the Eastern Michigan University Human Subjects Review Committee for use from 03/20/2012 to 03/20/2013. If you have questions about the approval process or suggestions with this study, please contact Dr. Deb de Laski-Smith (734.487.0042, Interim Dean of the Graduate School and Administrative Co-chair of UHSRC, human.subjects@emich.edu).

Should you have questions about this study, please contact

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