Engaging Students in 21st Century Skills through Non-Formal Learning

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ABSTRACT

National reforms, such as the *Next Generation Science Standards* (NGSS), *Common Core State Standards Mathematical Practices* (CCSMP), and *Partnership for 21st Century Learning* (P-21) challenge educators to provide students with dynamic learning experiences that address the needs of learners in today's society. These new standards represent a paradigm shift away from the meticulous content memorization of many state standards, toward more dynamic measures addressing the whole learner. To truly develop the leaders, innovators and thinkers of tomorrow, educators are beginning to look beyond the traditional schoolhouse walls to intertwine intentionally designed non-formal learning experiences within formal education. These non-formal experiences serve to connect seemingly disparate skills and knowledge through real-life, hands-on, minds-on learning. Embracing partnerships with individuals and organizations beyond the classroom fosters an environment seamlessly connecting life, work, and school.

Although the importance of student engagement in 21st century skills is at the forefront of current educational reforms, little has been done to assess this engagement. While standards such as Common Core State Standards and NGSS have measures in place for domain-specific 21st century skills, aside from PISA's cross-curricular problem solving test, there are few resources to measure non-domain specific engagement in these skills. Without a viable measure, detractors can argue that the term 21st century skills is meaningless and it distracts students from learning core content. Bridging the divide between skills and content is essential to build support for skills that reach far beyond isolated subject-matter knowledge. Engaging students in these skills through non-formal learning, and measuring the extent of student engagement in these skills will drive the development of future opportunities for students to hone them in creative ways.

The purpose of this study was to measure student engagement in 21st century skills while they participate in a non-formal learning experience. Once a viable measurement was developed, it was utilized to measure student percent of engagement in each specific 21st century Learning and Innovation skill (creativity and innovation, critical thinking, problem solving), Life and Career skill (flexibility and adaptability, initiative, self-direction and productivity, leadership, responsibility and accountability), and Socio-Cultural skill (communication and collaboration) while students participated in the intentionally designed non-formal learning experience of orienteering. The study also described what characterizes a viable non-formal learning experience facilitating student engagement in 21st century skills.

Analysis of data revealed the non-formal learning experience of orienteering engages students in 21st century Learning and Innovation Skills, Life and Career Skills and Socio-Cultural Skills. Specifically, communication and collaboration, critical thinking skills and initiative, self-direction and productivity comprise the largest student engagement. Engagement in leadership, responsibility and accountability, problem solving, and flexibility and adaptability are also evident. This particular non-formal learning experience facilitates very little student engagement of creativity and innovation. While not generalizable to a larger population, this study confirms that students immersed in a non-formal learning activity will become engaged in essential 21st century skills for school, life and work, therefore, this type of learning is a valuable part of instructional time within the formal instructional day and beyond.

Dedication

I dedicate this work to my two daughters, who inspire me with their independence, curiosity, and amazing life perspective. They graciously endured my absences from childhood weekends, evening events and soccer games throughout my career as a teacher and as a student. They learned to figure things out for themselves while I spent long evenings studying, grading, and writing papers. I am constantly amazed at the thoughtful and independent women they have become, and I look forward to being a part of their future journeys.

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CHAPTER 1: INTRODUCTION

"The map is not a substitute for personal experience. The map does not take the place of the actual journey" (Dewey, 1956, p. 20).

Overview

"To successfully face rigorous higher education coursework, career challenges and a globally competitive workforce, U.S. schools must align classroom environments with real world environments…" (P21 Mission section, n.d., para 2). This requires not only hands-on, problem-based simulation activities, but actual experiences beyond the classroom walls. Today's ideal learning environments are rich in creative thinking, problem solving and critical thinking opportunities. Integrative Science, Technology, Engineering and Mathematics (I-STEM) Education provides the framework to facilitate this shift, ushering in an era of integrative, problem based and design based experiences at the forefront of today's "classroom."

There is a profound disconnect between the knowledge and skills most students learn in school and those needed for real life. Gone are the days when compartmentalized knowledge and fragmented learning are deemed sufficient for our students. Essential skills for success in today's world are critical thinking, problem solving, communication, collaboration, creativity and innovation (P21, 2011). To prepare for work and life, students must learn to think for themselves while in the field, solve complex, often multi-faceted problems, and be able to communicate their decisions effectively. These multi-layered, unscripted problems that arise within authentic contexts are inherently integrative in nature (Humphreys, 2005). Participation in authentic, integrative problem solving experiences builds necessary life and career skills, such as flexibility and adaptability, initiative, self-direction, leadership and responsibility (P21, 2011). Educators must bridge the gap between knowing and doing, no longer treating knowledge as independent of the situation in which it is learned and used (Brown, Collins & Duguid, 1989).

Educational Paradigm Shift

National reforms, such as the *Next Generation Science Standards* (NGSS), *Common Core State Standards Mathematical Practices* (CCSMP), and *Partnership for 21st Century Learning Framework* (P-21) challenge educators to provide students with dynamic learning experiences that address the needs of learners in today's society. These new standards represent a paradigm shift away from the meticulous content memorization of many state standards under No Child Left Behind, toward more dynamic measures addressing the whole learner.

Next Generation Science Standards

The *Next Generation Science Standards* (NGSS) have introduced a conceptual shift in the vision for American science education. According to NGSS, K-12 standards emphasize "the interconnected nature of science as practiced and experienced in the real world" (Appendix A, p.1, 2013). Based on the *Framework for K-12 Science Education* developed by the National Research Council, NGSS stresses students' active engagement in scientific and engineering practices. Crosscutting concepts deepen student understanding of core ideas. According to NGSS, these science and engineering practices and crosscutting concepts are designed "to be taught in context-not in a vacuum" (National Research Council (NRC), 2012, para 2). NGSS emphasizes that scientific and engineering practices must not be treated as an afterthought. Combining practice with content provides context for learning, instead of practices alone (activities) and content alone (memorization). This integration sets the stage for meaningful learning experiences. The focus is not simply on teachers covering content, but on students developing deeper understanding and application of content.

NGSS (2013) core ideas are designed to "provide a key tool for understanding or investigating more complex ideas and solving problems" as well as "relate to the interests and

life experiences of students." (NGSS Introduction, p.3). NGSS acknowledges that with increased frequency, scientists are working in interdisciplinary teams that "blur traditional boundaries" (NGSS Introduction, 2013, p.3). Students must be provided experiences that encourage collaborative critical thinking and problem solving across disciplines.

Furthermore, NGSS acknowledge the importance of the affective domain in the development of concepts and skills in science and engineering. According to the *Framework for K-12 Science Education* "Research suggests that personal interest, experience, and enthusiasm—critical to children's learning of science at school or in other settings— may also be linked to later educational and career choices" (NRC, 2012, p. 28). Preparation for college, careers and citizenship is core to NGSS as well. Standards are intentionally designed to prepare students to innovate, lead and create jobs of the future.

Common Core State Standards

Another important feature of NGSS is the alignment with *Common Core State Standards* (CCSS) in English Language Arts and Mathematics (NGSS, Appendix A, 2013) and Partnership for 21st Century Learning (P21) skills. All three sets of standards overlap, providing a continuity of learning and the ability for educators to integrate subjects within meaningful, real-world learning experiences. This overlap is depicted in Appendix D.

The Standards for Mathematical Practice focus on "processes and proficiencies" important in mathematics education (Common Core State Standards for Mathematics, 2010, p.6). The process standards consist of problem solving, reasoning and proof, communication, representation, and connections. The proficiencies include adaptive reasoning, strategic competence, conceptual understanding, procedural fluency, and productive disposition. Productive disposition specifies that students should be inclined to perceive mathematics as

sensible, useful, and worthwhile. It also emphasizes a belief in diligence, and one's own self-efficacy (CCSS, 2010). The CCSS processes and proficiencies embolden educators to develop expertise in their students far beyond traditional mathematical computation and memorization.

Developed with the goal of ensuring that every student is prepared to succeed in college, career, and life, the CCSS specifically address 21st century needs (2010). For example, CCSS.Math.Practice.MP1, Make sense of problems and persevere in solving them, discusses student analysis of givens, constraints, relationships and goals. While this standard is applicable to multiple types of mathematical problems, the skills described extend far beyond any single school subject. This is further reinforced with CCSS.Math.Practice.MP3, Construct viable arguments and critique the reasoning of others. This standard encourages students to analyze situations, justify conclusions, reason inductively, communicate their reasoning to others, and respond effectively to the arguments of others (CCSS, 2010). CCSS.Math.Practice.MP5, Use appropriate tools strategically, and CCSS.Math.Practice.MP6, Attend to precision, also discuss skills applicable far beyond the scope of basic mathematics. They discuss the proficiency of students considering appropriate tools, visualizing the results of varying assumptions, exploring consequences, and communicating their reasoning to others precisely (CCSS, 2010). These standards were informed by the best existing state standards, the expertise of teachers, content specialists, states, leading thinkers, and public feedback. They further illustrate the shift in educational thinking, away from isolated content area competencies, toward a more holistic development of students prepared for today's work and life.

Partnership for 21st Century Learning

Founded in 2002 as a coalition to bring together the business community, educational leaders, and policymakers, the Partnership for 21st Century Learning (P21) serves as a catalyst to

position 21st century readiness in the center of educational policy and reform. With such founding organizations as The U.S. Department of Education, AOL Time Warner Foundation, Apple, Inc., National Education Association, and many more, P21 has grown into a force for educational reform, bridging business, education, and communities with a mission to foster the knowledge and skills all learners need to be life-long learners in a constantly changing world (P21 Vision and Mission, 2015). The basic tenets of P21 are the belief that learning takes place throughout life, and in many, varied places and spaces. A broad range of experiences is necessary for learners to thrive in today's world. All learners deserve 21st century learning opportunities, and "a strong foundation for success is rooted in learning that happens in and out of school" (P21 Vision and Mission, 2015). Preparing learners for the challenges of work, life, and citizenship in the 21st century and beyond requires 21st century learning environments and opportunities. Learners who possess these skills are essential for the innovations that drive our economy and the health of our democracy (P21 Vision and Mission, 2015).

P21 developed the *Framework for 21st Century Learning* to help practitioners integrate 21st century skills. It describes the knowledge, skills, and expertise necessary for success in work and life today. P21 divides these elements into "21st century student outcomes" that are "critical systems necessary to ensure 21st century readiness for every student" (P21 Framework for 21st Century Learning, 2015, p. 1). These elements are: Content Knowledge and 21st Century Themes, Learning and Innovation Skills, Information, Media, and Technology Skills, and Life and Career Skills (P21 Framework for 21st Century Learning, 2015, p.2). While content knowledge is still a key element, P21 describes Learning and Innovation Skills such as creativity, critical thinking, problem solving, and collaboration as equally important. Life and Career Skills such as flexibility and adaptability, and initiative and self-direction are also essential. According

to P21, “Today’s life and work environments require far more than thinking skills and content knowledge” (P21 Framework for 21st Century Learning, 2015, p.2).

Assessment

Global and national assessment agencies are recognizing that today’s complex and diverse society calls for a fundamental change in how we educate and assess our students. The Program for International Assessment (PISA) is a global assessment that measures 15 year-old students’ reading, mathematics and science literacy. In 2012, PISA added a cross-curricular problem solving test to its repertoire. While American students scored slightly above average on exams assessing their problem solving skills, students who took the problem solving tests in other countries, including Singapore, South Korea, Japan, several provinces of China, Canada, Australia, Finland and Britain, all outperformed American students. The problem solving results revealed that students in the highest performing nations were also able to think flexibly. Even on interactive tasks, the American students’ strength, all the Asian countries that participated outperformed the United States (OECD, 2012). “To understand how to navigate a complex problem and exercise abstract reasoning is actually a very strong point for the Asian countries,” said Francesco Avvisati, an analyst on the PISA team at the Organization for Economic Cooperation and Development (Motoko, 2014, p.A17). The fact that PISA now identifies problem solving as a discrete, measurable and essential competency illustrates a shift in the focus of the educational needs of our students today, from mere knowledge acquisition to the synthesis and analysis of information and flexible thinking necessary to solve problems, innovate and create.

Recognizing PISA’s shift toward a better prepared future generation, the National Assessment of Educational Progress (NAEP) moved toward broadening its assessments to

include college and career readiness and "21st Century Skills" such as communication and collaboration, problem solving, and persistence after failure which "cut across subject domains" (NAEP, 2012, p.6). In 2009, NAEP introduced a new science framework providing the theoretical basis for student assessment. The assessment measures content knowledge, but also goes beyond the basics, with hands-on components and interactive computer tasks measuring students' knowing and doing (procedural, schematic and strategic knowledge). Assessment of this content employs cross-cutting concepts among Physical Science, Life Science and Earth and Space Science. Science practices assessed take into account their cognitive complexity. Technological design questions are included, requiring students to apply their knowledge and skill to solve problems in real world context (NAEP, 2012).

The National Center for Education Statistics (NCES), which administers NAEP is committed to seeing these changes in its new procurement cycle for 2017. Among the changes is a new Technology and Engineering Literacy (TEL) Assessment being given to students in grade 8. This framework emphasizes student's problem solving process. Lonnie Smith, an assessment specialist at the Educational Testing Service explained "What we're looking at is not, are you able to solve the problem, but how did you go about solving the problem…we're trying to assess not whether students can arrive at a solution, which in my opinion is not telling of their abilities, but what is interesting is how do they get there?" (Heitin, 2014, p. 7). This metacognitive approach is consistent with the hands-on, active, intentional teaching of problem solving and the transferability of this skill. If students are to perform well on these assessments, they must be given multiple opportunities to integrate their knowledge into larger constructs and utilize problem solving skills to apply this knowledge to real problems in the field.

Rationale for the Study

Student success in college, career, and life depends upon much more than learning information, subjects and skills in isolation. To truly develop the leaders, innovators and thinkers of tomorrow, educators are beginning to look beyond the traditional schoolhouse walls to intertwine intentionally designed non-formal learning experiences within formal education. These non-formal experiences serve to connect seemingly disparate skills and knowledge through real-life, hands-on, minds-on learning. Embracing partnerships with individuals and organizations beyond the classroom fosters an environment seamlessly connecting life, work, and school.

When asked to rank skills in terms of importance, employers put professionalism, teamwork, and oral communication at the top of their list (Are They Really Ready to Work, 2006). While knowing how to problem solve, think critically, communicate effectively and collaborate with flexibility and adaptability are not unique to the 21st century, today's citizens must be prepared with these skills, as modern work and life requires their daily use for such tasks as analysis of information, decision making and collaborating to create new ideas (Silva, 2009). 21st century skills are critical to today's success, yet students are rarely engaged in them while sitting in a traditional classroom.

Even when students are engaged in 21st century skills, these skills are rarely measured. While there are some measures in place for use of these skills within specific subject areas, it is difficult to find assessments for student engagement in skills while participating in cross-curricular or non-domain specific activities. This study addresses the need to engage students in experiences that practice 21st century skills, as well as the need to measure student engagement in these skills during intentionally designed non-formal educational experiences.

Problem Statement

Although the importance of student engagement in 21st century skills is at the forefront of current educational reforms, little has been done to assess this engagement. While standards such as Common Core State Standards and Next Generation Science Standards have measures in place for domain-specific 21st century skills, aside from PISA's cross-curricular problem solving test, there are few resources to measure non-domain specific engagement in these skills. Without a viable measure, detractors can argue that the term 21st century skills is meaningless and it distracts students from learning core content. Bridging the divide between skills and content is essential to build support for skills that reach far beyond isolated subject-matter knowledge. Engaging students in these skills through non-formal learning, and measuring the extent of student engagement in these skills will drive the development of future opportunities for students to hone them in creative ways.

Purpose of Study

The purpose of this study was to measure student engagement in 21st century Learning and Innovation skills, Life and Career skills, and Socio-Cultural skills while participating in a non-formal learning experience. Once a viable measurement was developed, it was utilized to measure student percent of engagement in each specific 21st century Learning and Innovation skill (creativity and innovation, critical thinking, problem solving), Life and Career skill (flexibility and adaptability, initiative, self-direction and productivity, leadership, responsibility and accountability), and Socio-Cultural skill (communication and collaboration) while students participated in the intentionally designed non-formal learning experience of orienteering. Through these measures, educators can demonstrate the importance of non-formal learning

experiences for student engagement in 21st century skills. The study also characterizes a viable non-formal learning experience facilitating student engagement in 21st century skills.

Research Questions

RQ#1: To what extent are students engaged in the following 21st century skills while participating in a non-formal learning experience: Learning and Innovation Skills (creativity and innovation, critical thinking, and problem solving), Life and Career Skills (flexibility and adaptability, initiative, self-direction and productivity, and leadership, responsibility and accountability) and Socio-Cultural Skills (communication and collaboration)?

RQ#2: What characterizes a viable non-formal learning experience facilitating student engagement in 21st century skills?

Limitations of the Study

This research investigation was a case study involving ten participants who were seventh grade students at Blacksburg Middle School. The results of this study, therefore, cannot be generalized across populations, but they can provide an understanding, from the students' perspective, of their engagement in 21st century skills (Yin, 2014). Time constraints limited the length of time students could participate in the orienteering experience. Students participated during their science class period, which was 50 minutes long. Due to time constraints, detailed orienteering instruction was provided the day before the experience, with a short review on the day of the experience. Participants gained permission to stay after class for the debriefing interview. It is difficult to determine if this had any effect on the results, but if the students had block scheduling, they would have participated in all three parts of the experience seamlessly within one block.

Operational Definitions

21st Century Skills: a broad set of knowledge, skills, work habits, and character traits that are believed—by educators, school reformers, college professors, employers, and others—to be critically important to success in today's world, particularly in collegiate programs and contemporary careers and workplaces. 21st century skills can be applied in all academic subject areas, and in all educational, career, and civic settings throughout a student's life (Abbott, 2014, para. 1).

Behavioral engagement: Student involvement and participation in academic, social or extracurricular activities. Behavioral engagement is crucial for achieving positive academic outcomes and preventing dropping out. (Connell & Wellborn,1991; Finn,1989).

Cognitive Engagement: the psychological level of investment and the effort a student directs toward learning. It includes being thoughtful, strategic, and willing to exert the necessary effort for comprehension of complex ideas or mastery of difficult skills (Corno & Mandinach, 1983; Fredricks, Blumenfield & Paris, 2004; Newmann, Wehlarge, & Lamborn, 1992).

Creativity and Innovation: Individuals who demonstrate this use a wide range of creation techniques, create new and worthwhile ideas (both incremental and radical concepts), demonstrate originality and inventiveness in work and understand the real world limits to adopting new ideas, create new and worthwhile ideas (both incremental and radical concepts), and act on creative ideas to make a tangible and useful contribution to the field in which the innovation will occur (P21 Framework Definitions, 2015).

Critical Thinking: Individuals who demonstrate this use various types of reasoning (inductive, deductive, etc.) as appropriate to the situation, effectively analyze and evaluate evidence, arguments, claims and beliefs, analyze how parts of a whole interact with each other to

produce overall outcomes in a complex system (systems thinking), reflect critically on learning experiences and processes, analyze and evaluate major alternative points of view, synthesize and make connections between information and arguments , and interpret information and draw conclusions based on the best analysis (P21 Framework Definitions, 2015).

Flexibility and Adaptability: Individuals who demonstrate these skills adapt to varied roles, jobs responsibilities, schedules and contexts, work effectively in a climate of ambiguity and changing priorities, incorporate feedback effectively, reflect critically on past experiences in order to inform future progress, deal positively with praise, setbacks and criticism, exercise flexibility and willingness to be helpful in making necessary compromises to accomplish a common goal, and view failure as an opportunity to learn; understand that creativity and innovation is a long-term, cyclical process of small success and frequent mistakes (P21 Framework Definitions, 2015).

Initiative, Self-Direction, and Productivity: Individuals who demonstrate these skills set goals with tangible and intangible success criteria, balance tactical (short-term) and strategic (long-term) goals, go beyond basic mastery of skills and/or curriculum to explore and expand one's own learning and opportunities to gain expertise, set and meet goals, even in the face of obstacles and competing pressures, prioritize, plan and manage work to achieve intended results, monitor, define, prioritize and complete tasks without direct oversight, multi-task, and manage time and projects effectively (P21 Framework Definitions, 2015).

Leadership, Responsibility, and Accountability: Individuals who demonstrate these skills use interpersonal and problem-solving skills to influence and guide others toward a goal, leverage strengths of others to accomplish a common goal, inspire others to reach their very best via example and selflessness, demonstrate integrity and ethical behavior in using influence and

power, act responsibly with the interests of the larger community in mind, and are accountable for results (P21 Framework Definitions, 2015).

Learning:

Formal education: the hierarchically structured, chronologically graded education system, running from primary school through the university and including, in addition to general academic studies, a variety of specialized programs and institutions for full-time technical and professional training (Coombs, Prosser, & Ahmed,1973).

Informal education: the truly lifelong process whereby every individual acquires attitudes, values, skills and knowledge from daily experience and the educative influences and resources in his or her environment - from family and neighbors, from work and play, from the market place, the library and the mass media (Coombs, Prosser, & Ahmed,1973).

Non-formal education: any organized educational activity outside or beyond the established formal system - whether operating separately or as an important feature within some broader activity - that is intended to serve identifiable learners and learning objectives (Coombs, Prosser, & Ahmed,1973).

Learning and Innovation Skills: Essential skills that are increasingly being recognized as those that separate students who are prepared for the more complex life and work environments of the 21st century from those who are not. These skills include creativity, innovativeness, critical thinking, problem solving, communication and collaboration (P21 Framework Definitions, 2015).

Life and Career Skills: Essential skills that require more than thinking skills and content knowledge. These skills allow one to navigate the complex life and work environment of the globally competitive information age. They include flexibility and adaptability, initiative and

self-direction, social and cross-cultural skills, productivity and accountability, and leadership and responsibility (P21 Framework Definitions, 2015).

Problem Solving: Individuals who demonstrate this solve different kinds of non-familiar problems in both conventional and innovative ways, and identify and ask significant questions that clarify various points of view and lead to better solutions (P21 Framework Definitions, 2015).

CHAPTER II: LITERATURE REVIEW

The separation between knowing and doing becomes an issue in the formal learning environment. (Resnick, 1987). Principles, concepts and facts are often taught in an abstract and decontextualized form. In this atmosphere, knowledge itself becomes seen as the final product of education rather than a tool for solving problems. Non-formal education, by contrast, can be seen as education that occurs outside of this formalized, decontextualized setting, or simply put, learning that goes on in daily life. Bell, in conjunction with the National Research Council (NRC), discussed non-formal education in science as "rich with real-world phenomena…where people can pursue and develop science interests, engage in science inquiry, and reflect on their experiences through sense-making conversations" (2009). Non-formal education is the real-world, social, hands-on learning that is sometimes forgotten within the confines of formal education.

21st Century Skills

According to the Glossary of Education Reform, 21st century skills are a "broad set of knowledge, skills, work habits and character traits" (Abbott, 2015). Educators, school reformers, college professors, employers and others agree that these skills are critical for success in today's world, and they can be applied to all academic areas. They are sometimes referred to by such

related terms as applied skills, cross-curricular skills, cross-disciplinary skills, interdisciplinary skills, transferable skills, transversal skills and others, but while some of these names may be fairly synonymous, they also have other, more specialized meanings. The concept of 21st century skills is fostered by the belief that our schools and other institutions of learning should prioritize the most useful, relevant and in-demand skills for today's world (2015).

In his article *Rigor Redefined*, Wagner states "It's time to hold ourselves and all of our students to a new and higher standard of rigor, defined according to 21st-century criteria" (2008, p.25). He asserts that out of the myriad of classes he has observed in recent years, less than 1 in 20 engaged students in instruction deliberately designed to teach them to think rather than merely drilling for a test. Wagner touts the following "seven survival skills" (p.20) for students to become productive citizens dealing with 21st century issues: problem solving and critical thinking, collaboration and leadership, agility and adaptability, initiative and entrepreneurialism, effective oral and written communication, access and analyzing information, and curiosity and imagination (2008).

While some educators and school reformers refer to these skills as new, they have in fact been a part of human progress throughout history. According to Rotherham and Willingham (2009), what is actually new is the extent to which the changes in our world and our economy mean that success (collectively and individually) is dependent upon these skills. While there are many students who are being taught these skills, Rotherham and Willingham assert that up to this point in education it has been a matter of chance rather than a deliberate design of our school systems (2009). This deliberate design is difficult, however, as the body of knowledge and skills known as 21st century skills is not simple to define and has not been officially codified or categorized (Abbott, 2015). Assessment challenges will require deliberate attention from today's

policy makers and a deviation from current ways of thinking about educational assessment (Rotherham and Willingham, 2009).

A Pedagogical Framework for Non-Formal Education

A clear definition of specifically what non-formal education *is* can be elusive, as it is usually approached as a residual category- everything that is not formal education. This, however does a great disservice to this educational approach, as there are many rich and complex modes of learning involved in non-formal education. While formal education may fulfil learning needs prescribed by government, employment, or the education system, non-formal education can serve to fulfil broader goals as well as people's own life purposes, and can take place in forms chosen by the learner (Cairns, Merrifield & McGivney, 2000).

Since non-formal education is often described as what formal education is *not*, it is useful to clarify basic tenets of what would be described as "formal" education. In general, formal education:

- Has a prescribed learning framework
- Is an organized learning event or package
- Has a designated teacher or trainer
- Is offered for credit or a qualification
- Has specified outcomes (Eraut, 2000, p. 12)

Non-formal learning occurs across all of the different domains of our lives, with transfer and integration between the domains of work, home and community (Cairns et al., 2000).

Philosophical Underpinnings of Non-Formal Education

Constructivism

Any discussion of non-formal education must move beyond the simple focus on context or setting and look at the processes and experiences involved. Non-formal learning is inherently an active process, where the learner makes choices and acts upon them, constructing

meaning from experiences as they unfold. Drawing on the ideas of cognitive scientists such as John Dewey, Jean Piaget and Lev Vygotsky, constructivism is a learning theory about the nature of reality and how people understand the world around them. According to Dewey, "every experience lives on in further experiences" (1938, p.16). Constructivism asserts that people make (or construct) their own knowledge based on their experiences. Ideas do not have an exact true or false, but their viability is variable depending upon their context. Solutions to problems are dependent upon the situation and the factors involved in that situation (Callison, 2001).

Constructivist teaching is a type of "discovery learning," where the learners are actively involved in problem solving, as opposed to behaviorist teaching, where the learner is a passive reactor to the teacher (Callison, 2001). Non-formal education embraces the student-driven, discovery and idea-generated nature of constructivism. Learners bring previous experiences and expectations to the problem, and consider ideas relative to the situation. They construct meaning as they work through the problem. Fosnot and Perry define constructivism as a psychological learning theory that describes learning as "an interpretive, recursive, non-linear building process by active learners interacting with their surround- the physical and social world" (1996, p.23). These constructivist characteristics are woven throughout non-formal education. Educators bear the responsibility for facilitating these experiences, allowing students to build knowledge and expand their problem solving skills.

Constructing the Whole Learner

20th Century cognitive scientist Jerome Bruner described people as constantly seeking to balance their internal representation of the outside world through their observations (1960). Bruner's inquiry-based, constructivist learning theory asserts that learning occurs in problem solving situations. Students become problem solvers by interacting with their environment,

testing hypotheses and developing generalizations. Bruner believed the science curriculum should foster the development of problem solving skills through discovery and inquiry (Bruner, 1960). He outlined the five-stage process of perception, selection, inference, prediction and action. Bruner recognized that learning is an information-seeking process that involves thoughts, actions and feelings (Kuhlthau, 2004).

Lev Vygotsky (1978) declared that social learning is essential for driving cognitive development. His Zone of Proximal Development (ZPD) consists of tasks that lie between those a learner can accomplish without assistance, and those which require assistance. Optimal learning occurs when a learner is challenged, and the learning involves facilitated social construction of knowledge (Vygotsky, 1978). Bruner also discusses this level of uncertainty, believing that student's desire to learn and problem solve is fostered through problem activities in which the learner could explore alternative solutions (Bruner, 1966).

Robert Gagne's work with intellectual skills established prerequisite knowledge; essential knowledge one must possess to master subsequent higher order learning. This prerequisite knowledge is crucial for problem solving (1962). Albert Bandura's theory of self-efficacy describes our belief in our ability to perform a task. Self-efficacy is developed over time through the successes a learner experiences when interacting with his/her environment. Through the process of self-regulation, a learner sets goals for him/herself, monitors performance toward those goals, judges the adequacy of that performance, and makes modifications (Bandura, 1971). These pivotal learning theories espouse the cognitive, affective and social aspects of learning inherent in problem solving through non-formal education.

Theoretical Framework

Although there are multiple, and sometimes conflicting definitions of non-formal education, my research revealed seven basic commonalities that foster meaningful learning and form the underlying principles of the non-formal learning process. Students build usable knowledge through learning environments that:

- Foster integration of skills and knowledge to solve problems
- Provide meaningful activities within the context of an authentic learning environment
- Support collaborative construction of knowledge
- Promote the role of the teacher as facilitator
- Embolden the student to be an active, autonomous, self-regulated decision maker
- Provide continuous, formative and authentic assessment within tasks
- Promote reflection and articulation to foster the formation of abstractions and enable tacit knowledge to become explicit.

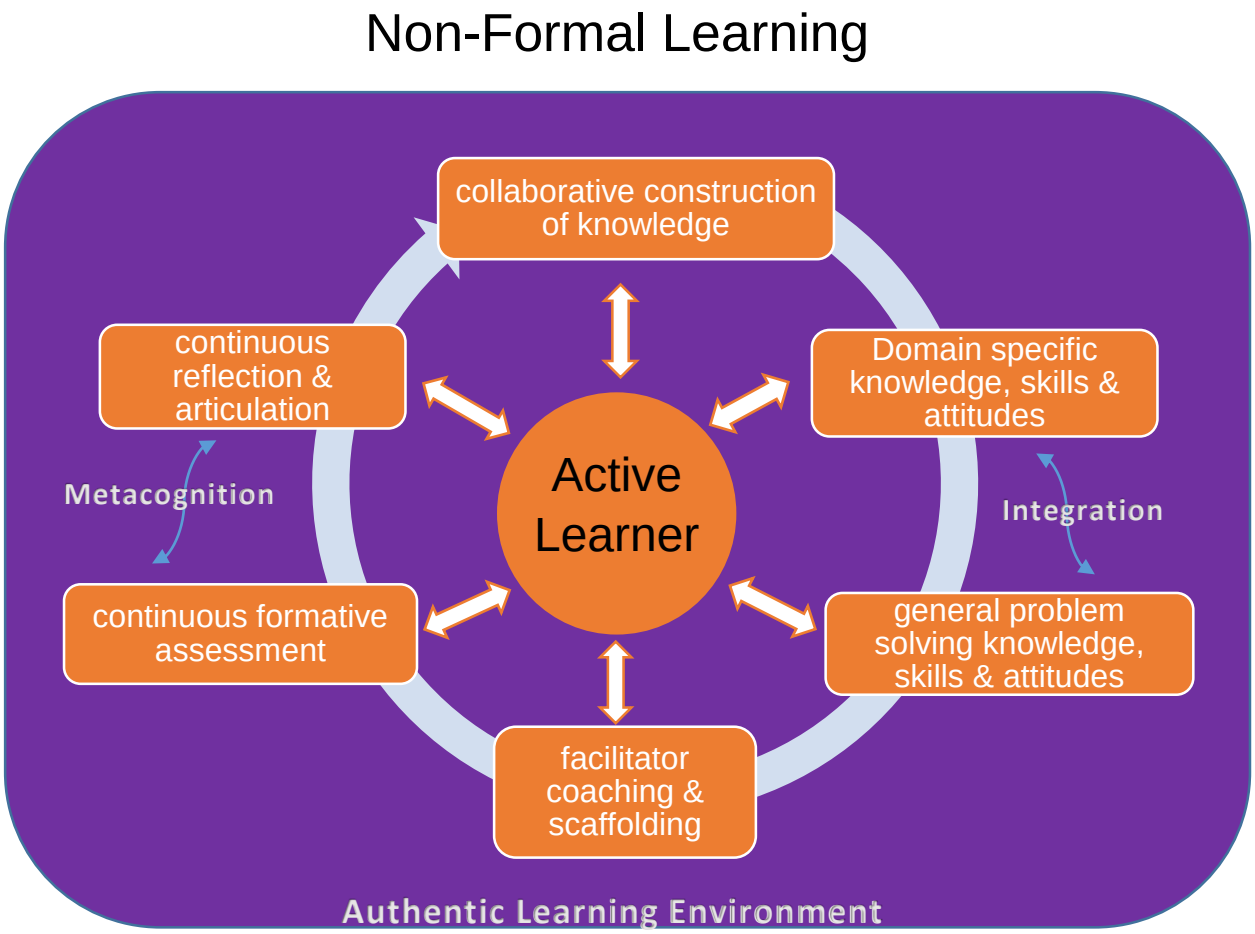

Figure 1: Non-Formal Learning

Integration of Domain Specific Knowledge, Skills, and Attitudes

Integrative learning is vital for preparing students to deal effectively with the complex issues they will face in work and everyday life. Integrative thinkers can see connections in information that seems disparate. They draw on an extensive range of knowledge to make decisions, and they can adapt what they learn from one situation to problems in other situations (Greater Expectations National Panel, 2002). According to Nussbaum (1997), students prepared for twenty first century life must be able to work through complex interdependencies, synthesizing from many, varied sources. They should learn from experience and be able to make productive connections between theory and practice. Integrative teaching approaches must foster students' capacity to begin making connections for themselves. Both fully integrated learning and learning with a purpose are fundamental elements of the non-formal learning process (Griffin, 1998).

Situated Learning

Learning is a complex and continuous life-long process. It is not only situated within a series of contexts, it results from acting within situations (Brown, et al, 1989, Falk & Dierkin, 2000). Simply put, learning is a contextually driven effort to make meaning. It involves a continuous exchange between the learner and his/her physical and sociocultural environment. (Falk & Storksdeick, 2005).

Coherent, meaningful, and purposeful learning activities are authentic. Classroom activities that take place within the culture of schools are not the same as the activities or the culture of actual practitioners (Brown, et al., 1989). The formal definitions, clear-cut, well defined problems, and symbol manipulation within the school culture do not allow learners to develop the general strategies for intuitive reasoning, negotiating meaning and resolving issues

that are experienced in everyday life and work (Lave, 1988). This culture limits student's access to the important structuring and supporting cues that are developed from context. Classroom tasks often fail to provide the contextual features that allow authentic activity. As a result, instead of the desired goal of in-school learning, success within the formal school culture often has little effect on a learner's performance elsewhere (Brown, et al., 1989).

Due to the nature of classroom tasks, transfer of knowledge within the confines of the school culture is extremely difficult. When a learner experiences concepts in multiple contexts, he/she learns different ways the knowledge can be used. From these various experiences, the learner begins to generalize his/her knowledge. This knowledge can then be utilized in multiple ways and within various contexts. This is opposed to the abstract way knowledge is often taught within the structure of school. All too often, school's abstract structure encourages students to employ substandard strategies like storing information just long enough to retrieve it for a test (Collins, 1989). It is never truly internalized or placed within a usable context, and it is unlikely to be used to solve problems outside of the constructs of school. Learning through multiple contexts, both within and outside of the general school culture encourages students to generalize across domains, and apply their knowledge in unique and flexible ways throughout various situations. Learning that is meaningful for solving real world problems is complex and situated within a series of contexts.

Collaborative Construction of Knowledge

Learning comes from experience, but both learning and experience are socially constructed and reconstructed. (Cairns et al., 2000). Learning is defined by the cultural contexts in which it occurs. Through participation in various cultures, people develop behaviors, beliefs and practice that make meaning of their world. All of these are established as social practices

within a given context. The process of learning from experience shapes the learner's development. Since learning is a social process, the learner's development is molded by his/her cultural system of social knowledge (Kolb, 1984). Because of the socio-culturally situated nature of learning, learners are powerfully influenced by the interactions and collaborations they have with learners from their own social group (Falk & Storksdieck, 2005).

In their multimedia program study, Herrington and Oliver (2000), discussed the benefit students found when articulating, reflecting and scaffolding with a partner. They discovered that if not given a partner with whom to work, students will covertly seek opportunities to collaborate. According to Vygotsky, people develop individual cognition as a result of their social interaction (1978). Resnick, in her 1987 Presidential Address pointed out that much of formal school learning and measurement of performance is individual, but most of our activity outside of school is socially shared. Real life takes place within social systems, and a learner's ability to function successfully depends upon working within this social system (Resnick, 1987). Sharing of knowledge is necessary to solve the real, complex, ill-structured problems we face every day.

The Role of Teacher and Learner

Learning is optimized when students have choices and feel they are in control of their own learning (Falk & Dierking, 2000). Self-directed learning involves students choosing what they will learn based on need, anticipated use, or interest. It also involves self-determination of pacing both physically (how quickly a student moves through a physical process) and mentally (when to slow down and focus on details and when to superficially take in the whole picture). Griffin (1998), in her baseline study found that most teachers on a field trip or in a non-formal learning situation had a task oriented approach. When their strategies moved from teacher-

centered to learner-centered, the outcome was self-directed learning. Griffin determined that that the key to successful learning experiences is not just teacher strategies, but the full set of self-directed learning conditions which are provided throughout the non-formal learning experience. One of her most significant findings was the extent and level of learning achieved by students when given freedom to learn through self-direction. When exploration is encouraged, learners are able to try different hypotheses, methods and strategies to see what happens. This puts learners in control of problem solving. The facilitator is there to guide the learners and show them how to explore productively. Through autonomous, facilitator-guided exploration, students learn how to problem-find and set achievable goals (Griffin, 1988).

Learners thrive in environments that acknowledge their needs and experiences. Students should be asked questions whose answers need to be figured out, not just recited from memorized facts. "They need to be treated like sense-makers rather than rememberers and forgeters" (Lampert, 1986, p.340). It is imperative that students make connections between what they are supposed to be learning and the things that they care about understanding. Students who are given the freedom to think for themselves, figure things out, and make decisions based on their learning develop the capacity to gather information, organize it strategically, generate and test hypothesis, and produce as well as evaluate solutions. They become comfortable discussing what they are thinking, they develop the ability to listen, appreciate, and build from others' ways of understanding, and they learn to invent problem solving procedures that are sensible and useful (Lampert, 1986).

Problem Solving Knowledge, Skills, and Attitudes

Problem finding has been identified as the most critical skill for success (Getzels, 1979**),** yet it is rarely explicitly taught or even practiced in the formal school environment. Learners

need practice in setting reasonable goals and revising their goals as they progress deeper into a problem. Schools emphasize well defined tasks instead, unlike any problems in the real world. Practicing how to form and test hypotheses within the context of real problems is pivotal for making sense of the world and solving problems. Learners who practice this within many different domains and with the guidance of a facilitator will not only learn to effectively navigate real-world problems, they will start making discoveries on their own. Learners will get a feel for what it is like to be a scientist while they make and test hypotheses. They develop a sense of enjoyment and accomplishment from creating their own ideas and seeing if they work (Collins, 1989).

Continuous Formative and Authentic Assessment

Learning is an emergent process, and therefore cannot be assessed strictly through a set of expected outcomes. Ideas are not fixed and incontrovertible elements of thought. They are formed and reformed through experience. Every piece of understanding is the result of the process of continuous construction and invention. The interaction process of assimilation and accommodation allows this to occur (Kolb, 1984). This is why continuous, formative and authentic assessment is so important.

An authentic assessment gives students a task that is worthwhile, significant, and meaningful (Hart, 1994). It confronts student with the same types of activities that are carried out in professional practices. When students are given a meaningful learning task, they must utilize higher-order thinking skills and integrate a broad range of knowledge to build competencies instead of memorizing information and basic skills. Instead of a passive listener, the student is an active participant, building skills throughout the task. The assessment is continuous and

formative, giving students the responsibility for their own learning, reflecting, collaborating, and engaging in continuous dialogue with the teacher (Gulikers, Bastiaens, & Kirschner, 2004).

Reflection and Articulation to Foster the Formation of Abstractions and Enable Tacit Knowledge to Become Explicit.

Learning only becomes generalizable to new situations when the student can recognize elements of the context in which the original learning occurred within that new context (Perkins & Salomon, 1989). Therefore, transfer needs to be facilitated. When knowledge is tacit, it can only be used in contexts that elicit the knowledge because the contexts are very similar to the conditions in which it was acquired. When learners must articulate their knowledge, it generalizes the knowledge from a particular context so it can be used in other circumstances. This allows knowledge to be more available and utilized in other tasks. Articulated knowledge becomes part of a set of interconnected ideas and becomes more easily available.

When learners articulate strategies, they can begin to realize how their strategies apply in different contexts. Insight into alternative perspectives is achieved when learners discuss their strategies in groups. Not only do learners hear various perspectives, their own articulation promotes insight into alternative perspectives. When a learner attempts to explain an idea or a problem, he/she begins to understand it from different perspectives. Responses from other learners allow insight into difficulties that others may have, and the way different people view the same issue (Collins, 1989).

Problem Solving, Metacognition and Transferability

The ability to think about one's problem solving activities can mean the difference between being a poor problem solver and an effective one (Gardner, 1991). Metacognition (awareness of one's own cognitive processes) allows students to identify and work strategically

within the parts of the problem solving process. Metacognitive skills foster students' ability to strategically encode the nature of the problem and form a mental representation of its elements. Students may then choose appropriate plans and strategies for a solution, and identify and overcome obstacles that hamper progress (Davidson & Sternberg, 1998).

Metacognition includes the planning, monitoring and evaluation of the problem solving process, and improving skill in these areas can increase performance in a wide variety of situations. When students must give reasons for their decisions, and verbalize the steps they took while problem solving, it focuses their attention on their own solution process. Use of intentional metacognition will not only improve current performance, it will transfer to other problems for improved performance in multiple tasks (Dominowski & Dallob, 1995). Students' verbalization of their problem solving practice facilitates the discovery of the general process of solving problems and it assists in allowing them to better utilize these skills in future problem situations (Gagne & Smith, 1962). Knowledge about their own mental processes and the process of problem solving itself helps students become better problem solvers in school and work situations, as well as everyday life.

A Pedagogical Framework for Orienteering

According to Ericsson, Krampe, and Tesch-Romer (1993), expert performance is developed through deliberate practice. Orienteering provides an optimal environment for fostering 21st century skills. Students gain practice in ill-structured problem solving, developing declarative, procedural, schematic and strategic knowledge. Orienteering encourages flexibility and motivates students to persist in difficult situations. It encourages positive collaboration and teamwork, leadership skills, initiative and self-direction, and it brings tacit knowledge to light through facilitated articulation. As orienteering is a form of non-formal learning, constructivism

offers a solid foundation for the development of essential 21st century skills within the experiential, outdoor learning context of orienteering.

Orienteering is situated learning, immersing students in the outdoor environment, while challenging them to think strategically and problem solve with peers. In an experiential learning orienteering experience, participants are given a detailed map with control points marked throughout the course. Students must plan the best route to all control points in the least amount of time. The experience challenges students both mentally and physically to navigate new and diverse terrain, problem solve, think strategically, work collaboratively, and make decisions in the field. Throughout the experience, students monitor their progress, often changing their course of action multiple times. Original plans become less than ideal when terrain is more difficult than anticipated, obstacles prevent progress, or time dictates a necessity to change the route. Students must constantly regroup, analyze their strategies, and devise varied solutions. They test their solutions immediately in the field, and must re-evaluate and problem solve again if the solution fails to produce the desired outcome. The facilitator scaffolds the students as needed to assist in providing a zone of proximal development (Vygotsky, 1978) that is neither too obvious nor frustrating to a point where students are unable to make meaning of their situation. This deliberate practice in strategic planning, problem solving and decision making serves to develop the 21st century skills necessary for success not only within the rigor of changing future assessments, but in higher education and everyday work and life.

The pedagogical framework for orienteering specifically is reflective of the basic tenets of non-formal education in general. Students work in collaborative teams to create strategies for locating control points and navigating diverse terrain. The process is iterative, with students moving between specific domain knowledge, skills and attitudes and general problem solving

knowledge, skills and attitudes. Students continuously collaborate to reflect upon their actions, articulate their progress and assess strategies. Through this process of self-assessment, metacognition and articulation, they make their tacit knowledge explicit. The facilitator scaffolds as needed, filling in knowledge if a task lies beyond the scope of the learners. The facilitator also poses thought-provoking questions, guiding student's problem solving process. A facilitated debriefing at the end of the experience provokes additional meaning-making, continuing the cycle of collaborative construction of knowledge and enminding students into a community of practice. The following model illustrates this process:

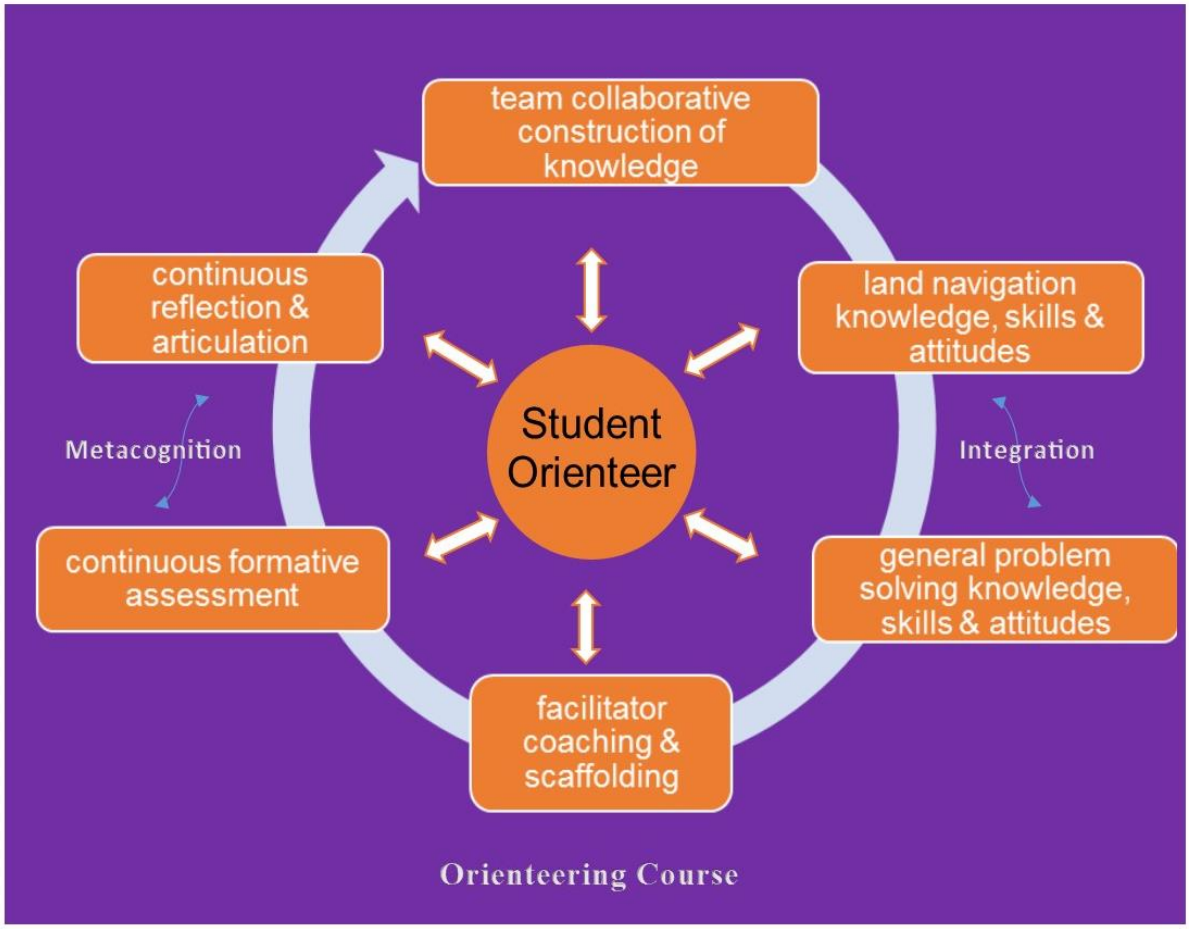

Figure 2: Orienteering Learning Process

Necessary Teacher Pedagogical Knowledge

Requisite pedagogical knowledge that teachers must possess in order to engage students in 21st century skills through orienteering experiences follows the heuristics of constructivist teaching. First and foremost, teachers must remember that the experience is student-centered. The teacher is not the purveyor of knowledge, and the purpose of this experience is for students to learn to problem solve and make meaning for themselves. This requires that the teacher create a non-threatening environment that encourages flexible and creative thinking. Students must feel comfortable to innovate and encouraged to express their cognitive and metacognitive processing, including frustrations, throughout the experience. This approach includes recognizing prior learning, attitudes, perceptions, and expectations (Griffin 1998).

Teachers must have specific knowledge of 21st Century Learning and Innovation Skills and Life and Career Skills. They must recognize the importance of developing students' creativity and innovation, problem solving and critical thinking, and communication and collaboration. It is paramount that they encourage student flexibility and adaptability, initiative and self-direction, productivity and accountability, and leadership and responsibility. Teachers must recognize the importance of the social aspects of solving problems as a team. They must understand that success in today's life and work environment requires students to possess more than simply thinking skills and content knowledge (P21 Framework for 21st Century Learning, 2015, p.2).

Teachers must also possess the pedagogical content knowledge to provide a short, basic map and compass lesson prior to the experience, showing students how to orient their maps. They must also provide basic directions for the activity, as well as informing students of the overall goal to find as many control points as possible within the allotted time. Teachers may also set up the course and draw a map, or utilize an existing map to plot points. This is fairly basic map and

compass content knowledge, and teachers who do not feel confident setting up a course can rely on help from a local orienteering club or outdoor company who provides these services.

After this basic instruction, the teacher becomes the facilitator or coach, only scaffolding students as needed and providing questioning to encourage innovation, collaboration and problem solving. This type of cognitive apprenticeship facilitates learning through guided experience, focusing on 21st century skills. This allows conceptual and factual knowledge to be situated within the context of its use. When this occurs, conceptual knowledge can become known through its uses in a variety of contexts. This type of coaching facilitates transfer of knowledge and deeper understanding (Collins, Brown, & Newman, 1987). Teachers who facilitate a meaningful orienteering experience maintain a dual focus on these expert processes and situated learning.

Further pedagogical knowledge includes recognition of Vygotsky's zone of proximal development (1978). The teacher must have the ability to monitor the students' level of frustration, and decide when scaffolding is necessary, as well as when he/she should wait and observe whether students can problem solve through difficult situations unassisted. This decision will be made easier when teachers possess pedagogical knowledge in problem solving competency, and the process of developing through the stages from novice to exert.

Assessment of student engagement in 21st century skills within a meaningful orienteering experience requires that teachers be well-versed in practices of on-going, formative assessment. They should also be able to ask thought-provoking questions that encourage rich discussion and articulated metacognition through varied debriefing strategies. Drawing from this debriefing, teachers must be able to gauge student engagement in 21st century skills.

Teachers who can draw upon constructionist pedagogical knowledge and knowledge of 21st century skills can successfully conduct a meaningful orienteering experience with minimal additional pedagogical content knowledge, or help from experts within the field of orienteering. While it does not always happen in the formal educational setting, nurturing students' 21st century skills within the context of a motivating and meaningful experience should be a key focus for all educators. In the current standardized testing culture, it is easy to lose sight of our goal as educators to foster autonomous life-long learners who enjoy creatively and collaboratively solving problems.

Conducting an Orienteering Problem Solving Experience

The best example to illustrate the framework so a teacher can intentionally structure a student's learning in an orienteering problem solving activity is to walk through the experience step-by-step. There are important considerations for structuring the learning throughout each step of the process.

Creating a Course

An orienteering course can be set up in a schoolyard, park, wilderness area, or even inside a building if weather is a factor. Course difficulty depends on age level and experience. Typical middle school students with little or no orienteering experience will benefit from a moderately difficult course, with some control markers more easily found, while other "challenge" markers will push the limits of the group and in some cases may not be found. As the teacher places the control markers (similar to flags) with punches throughout the course, he/she will plot them on a map. An existing map may be used, preferably containing topographical information, or teachers may create their own. If this step is too time consuming or

difficult, teachers may seek help from experts in the field through orienteering clubs or outdoor businesses who conduct orienteering competitions.

Student Preparation

The teacher will divide students into dyads or small groups, providing each group with a compass, a punch card, and a copy of the map. He/she will show the students a control marker and model how to punch their card in the numbered squares. Students can practice this on their own punch card by punching a designated box for the example. The teacher explains that each punch has a unique hole pattern, and this is how we know that you have visited a control marker. The teacher then guides the students through the process of orienting the map by asking questions such as:

a) Can you find where we are on this map?
b) Is it easier to read the map when it is turned in a different direction (upside down, etc.)?
c) Can you match your compass north to north on the compass rose of your map?
d) Which way does this require you to turn your map?
e) Can you see any visual landmarks in real life and on your map that help you orient the map?
f) How can orienting your map in this way help you while you are looking for control points?

The Teacher can scaffold this activity by pointing out obvious visual landmarks and helping the students orient their maps to them. He/she can also give more detailed instruction on compass skills and topography.

Strategy

The teacher explains that the goal of orienteering is to accumulate as many points as possible in the shortest amount of time. Each control marker is worth a certain number of points depending upon level of difficulty. There is a time limit for the course, and at the end of the activity, teams must arrive back at the base camp (starting point) within that time limit. If they

are late, they will be docked a significant amount of points for each minute beyond the time limit they arrive. The teacher may emphasize that teams are not required to find every single control marker, although they will want to try, and that teams can start with any control marker and they can search for and find control markers in any order. The ultimate goal in an orienteering competition is to "clean" the course (get to all of the control markers) and be the first team back to base camp. Students can decide whether to rush off and start searching, or whether to take a few minutes to study the map and devise a plan. The teacher can scaffold this by asking questions such as:

a) Is there a logical order to these based on terrain, placement and/or points?
b) Is it worth taking the time to create a strategy? Why?
c) Which control markers would you skip if you ran out of time? Why?

This is where students begin to collaborate and think critically, coming up with creative and innovative methods for gaining as many points as possible.

And They're Off!

Students are heavily engaged in each of the 21st Century Learning and Innovation, Life and Career, and Socio-cultural skills. This is also where it is important to keep in mind students' frustration level, zone of proximal development (Vygotsky, 1978), and students' problem solving processes. Examples of scaffolding problem solving and metacognition through authentic problems in the field are as follows:

Scenario 1

The students are in the vicinity of a control marker, but cannot seem to locate it. They are frustrated, worried about time, and are trying to decide whether to continue the search or move on to another control marker.

Examples of questions to scaffold problem-solving and metacognition:

a) Where do you think the control marker should be? Why?

b) Take another look at your map. Can you find a visual landmark to help you orient it? So now where do you think the control marker should be?
c) From which direction did you come? Were you looking along the way? So where could you look now?
d) How many points is this control marker worth? Is it worth your time to take a few more minutes to search since you know you must be near it?

Scenario 2

The students had a strategy for reaching a control marker that is worth several points, but they find that their path is blocked by large brush and thorny brambles.

Examples of questions to scaffold problem-solving and metacognition:

a) What was your strategy for this one? It looks like you'll need to rethink that strategy. Any ideas?
b) Going that way to find the control marker puts you far away from the next one you planned to find. Is it worth it to change your order or skip one of them?

Scenario 3

The students have only two control markers left, but they only have 15 minutes to arrive back at base camp. One member of their team is extremely tired, and not sure if he can make it much farther.

Examples of questions to scaffold problem-solving and metacognition:

a) How far away do you estimate each control marker to be? How fast have you been traveling? Does that allow you enough time for both?
b) Does everyone in the group have to go all the way to punch the marker?
c) If you need to choose, which control marker should you go for? Why?
d) How do you feel about your point total right now? Would it be safer to head back to base camp?

Debriefing

Facilitated debriefing is an important facet of developing students' knowledge of their engagement in 21st century skills through orienteering. It also encourages student reflection about their thinking, collaboration and problem solving process (metacognition), articulation (making tacit knowledge explicit) and comparison of strategies (promoting insight into alternative perspectives). The teacher can facilitate these outcomes through thoughtful questioning and open discussion. Questions that encourage productive reflection include:

a) Did your group begin with a strategy or develop one along the way? What was it?
b) Why was it helpful to have a strategy?

c) Did your strategy change during the course? What changed? Why?
d) Were control markers where you originally thought they were? What did you do when they were not? Why? Did this work? Why/why not?
e) Did all team members agree on strategies and decisions throughout the experience? What did you do when they did not? Did it work? Why/why not?
f) What could you have done differently?
g) What do you think were your strengths? Why do you think this was something you were particularly good at?
   Which of your strategies or decisions were especially inventive or creative? Did you come up with a way of doing something that was different than what others did?
h) What did you learn or figure out as you went?
i) What knowledge would help you do better next time you try this?
j) Tell me the process you used to problem solve when you had difficulties.
k) How could this experience help you solve a different kind of problem at home or at school?
l) Is there anything else you want to tell me about the experience?

While the task may seem daunting at first, an orienteering experience provides a simple, fun, yet challenging opportunity to get students active, outside and engaging in 21st century skills.

Summary

As Wells (2008) asserts, I-STEM education stresses content in real, meaningful contexts, intentionally designed to guide students through purposeful inquiry and develop meaningful connections. Engaging in 21st century skills through orienteering is an example of an I-STEM experience that is not constrained by classroom content domains. As in the real world, solutions to problems are not predictable or convergent. People must be flexible and adaptable, and solve problems through collaboration, critical thinking, creativity, flexibility, and innovation. The orienteering experience fosters student engagement in authentic learning, encouraging students to recognize relationships among disciplines and effectively utilize them to solve real, complex problems. For success in 21st century life, students need to be cognizant of these complex interdependencies. Students must learn from experience to be able to connect theory and practice (Humphreys, 2005; Nussbaum 1997).

CHAPTER III: METHOD

Presented in this chapter is the methodological framework for this investigation which includes the following sections: research questions, research design, pilot study, participants, data collection procedures, data analysis (quantitative, qualitative, and mixed), and summary.

Research Questions

For success in our dynamic, global society, today's students require far more than the traditional education delivered within the classroom walls. It can be argued that non-formal learning, whether conducted within school hours or beyond, is integral to the development of 21st century skills. This authentic engagement allows students to acquire the real-world expertise necessary to thrive in today's ever-changing society. Guided by the following questions, this research seeks to demonstrate the potential for authentic non-formal learning experiences to serve as viable educational pathways for student acquisition of 21st century skills.

RQ#1: To what extent are students engaged in the following 21st century skills while participating in a non-formal learning experience: Learning and Innovation Skills (creativity and innovation, critical thinking, and problem solving), Life and Career Skills (flexibility and adaptability, initiative, self-direction and productivity, and leadership, responsibility and accountability) and Socio-Cultural Skills (communication and collaboration)?

RQ#2: What characterizes a viable non-formal learning experience facilitating student engagement in 21st century skills?

Research Design

Yin (2003) describes the case study as an empirical inquiry that "investigates a contemporary phenomenon within its real-life context, especially when the boundaries between the phenomenon and context are not clearly evident" (p. 13). Following Yin's definition and

based on the literature review presented in chapter 2, it was determined that case study was the best method to answer the types of research questions posed. It allows the researcher to study small group behavior in a holistic, real-world setting (Yin, 2014). Because this research was conducted with several small groups, a multiple-case sampling was the appropriate case study approach to answer the types of research questions posed (Miles & Huberman, 1994) and a logical fit when considering the type of information sought in this study. Specifically, the goal of this research was not to generalize across populations, but to establish a better understanding of the relationship between the acquisition of 21st century skills and non-formal learning. As well, because the research was also looking to characterize what might constitute viable non-formal learning experiences for student acquisition of 21st century skills, a multiple case sampling was appropriate for determining such viability.

Data collected within the multiple case studies followed a fully integrated mixed method monostrand conversion research design (Teddlie & Tashakkori, 2006). Both qualitative and quantitative components influenced the conceptualization stage of the study (establishment of relationships), with crossover analysis directly influencing the formulation of meta-inferences (viability), thus necessitating this integrated mixed method monostrand conversion design. Multiple phases were necessary for triangulating the qualitative and quantitative data from this study (Figure 3).

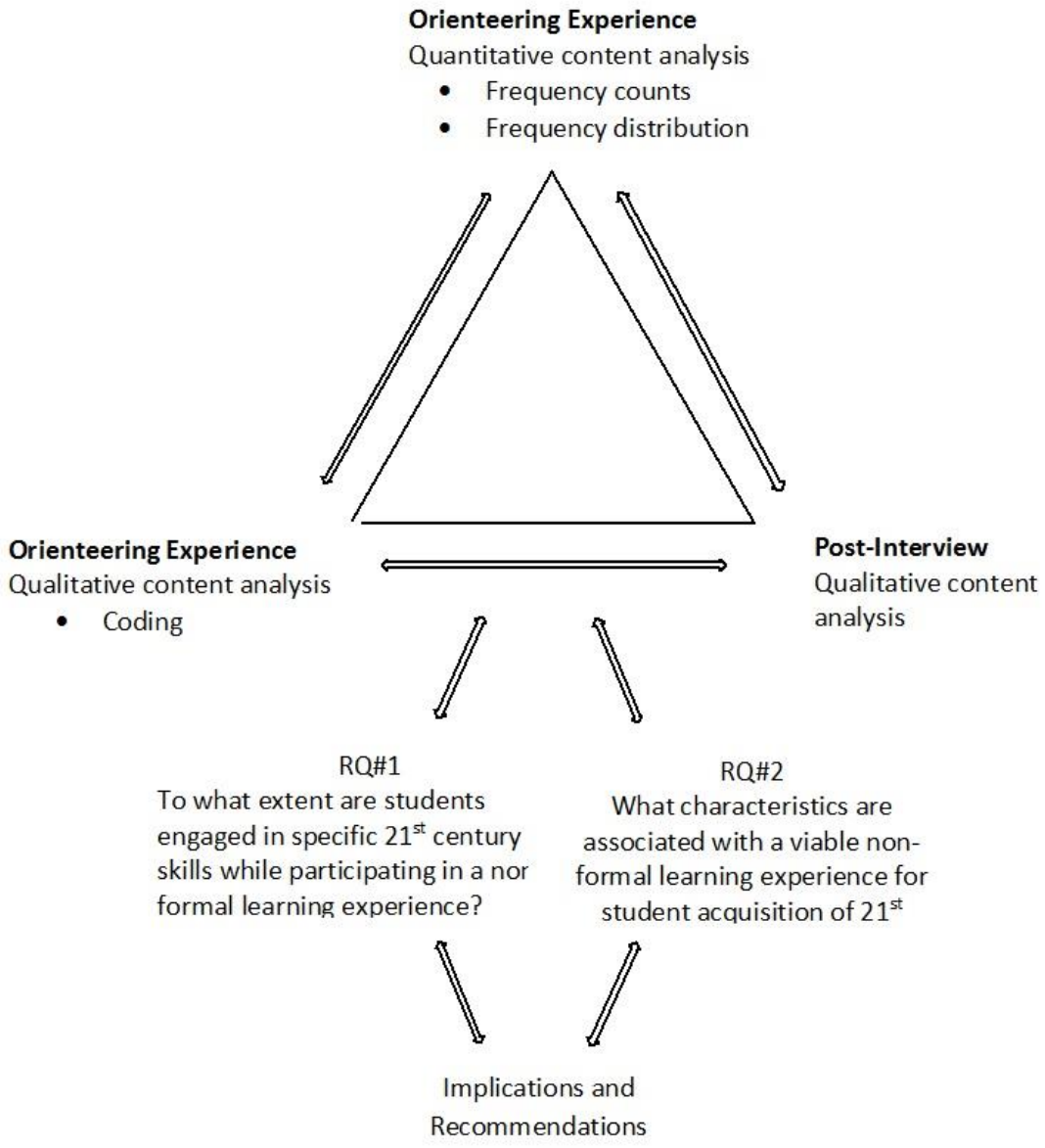

Figure 3. Triangulated mixed methods design for this study

This model represents the process of methods triangulation followed in this study. Presented in Table 1 below are techniques employed in data collection, sources of those data, and method used in analyzing those data.

Table 1.

Alignment Between Research Questions, Data Sources, and Analysis Procedures

Question	Data Collection Method	Data Analysis
RQ#1: To what extent are students engaged in the following 21st century skills while participating in a non-formal learning experience? 1. Learning and Innovation A. Creativity and innovation B. Critical thinking C. Problem solving 2. Life and Career A. Flexibility and adaptability B. Initiative, self-direction and productivity C. Leadership, responsibility and accountability 3. Socio-Cultural A. Communication B. Collaboration	• GoPro Video Recordings • Interview Video Recordings	<u>Quantitative</u> • Frequency counts • percentage occurrences • measures of central tendency <u>Qualitative</u> • Content analysis (coding) • Corroborative analysis
RQ#2: What characterizes a viable non-formal learning experience facilitating student acquisition of 21st century skills?	• GoPro Video Recordings • Interview Video Recordings	• Content analysis (clustered summary table) • Corroborative analysis

Video recordings from the orienteering experience were transcribed and analyzed qualitatively using a coding rubric developed by the researcher (Appendix O). The coded data were then analyzed quantitatively to produce frequency counts and frequency distribution. Corroborative analysis was conducted on this data, along with content analysis to develop further meaning. The post-interview was also analyzed qualitatively through conceptual and relational content analysis, and analyzed corroboratively with both the qualitative and quantitative data

from the orienteering experience. A clustered summary table, based on the coding rubric, ordered the cross-case data sets and facilitated deeper understanding of the phenomenon, thus ensuring that the study was rich, robust, comprehensive, and well-developed (Creswell, 1998).

To establish the fidelity of the method used in conducting this research a pilot study was first conducted (Appendix Q). The pilot study resulted in the instruments, coding scheme, and procedures for data analysis.

Participants

The participants in this study consisted of 20 seventh grade students ages 12-13 enrolled in a Life Science class at a mid-sized suburban middle school. The population was composed of 55% (11/20) male and 45% (9/20) female. Students in each class were all randomly assigned to dyads. Only two dyads per class were randomly assigned to wear GoPro® cameras and participate in post-interviews. This approach was designed to provide 10 data sets.

Procedure

After a short introduction to basic orienteering, students participated in a 35-minute orienteering experience with 15 control markers on the school grounds. The course presented several natural challenges, including distance, terrain, thick branches, thorns, and underbrush. Higher point values motivated students to seek the more difficult control markers within the allotted time provided for the orienteering experience. The 35-minute time limit and large size of the course encouraged students to have a plan and run through the course as quickly as possible. The following section details the experience provided for participants.

Intervention

Pre-Orienteering. Pre-experience instruction is critical for preparing participants in the basics of orienteering such as how to read a map, what to look for, where to look, and basic

rules. This requires approximately 20 minutes to complete. Because the middle school schedule allows only 57 minutes of class time, it was necessary to prepare the students in advance so they would have an entire 57-minute period on the day of the actual orienteering experience. The Thursday before the orienteering experience (scheduled for the following Monday), the researcher visited each class for approximately 20 minutes to explain orienteering to the students and to teach them how to "orient" a map (Appendix H).

Course Construction. A course location on school grounds was determined after a meeting with the teacher and a visit to the school two weeks prior to the orienteering experience. A map was created using Google Maps (2015) earth view of the middle school grounds and adding fifteen red numbered circles to indicate where the control markers would be placed (Appendix I). Point values for each control marker were indicated at the bottom of the map. A scorecard (Appendix J) was also created consisting of numbered boxes intended for students to hole punch (Appendix K). A hole punch was attached to each control marker. Each punch created a unique pattern when hole-punched into the scorecard. The unique pattern in the scorecard indicates to the facilitator that the students located that particular control marker.

The course, consisting of 15 control markers of various sizes (Appendix K), was set up the Sunday afternoon before the Monday orienteering experience. Control markers of three different sizes (small, medium, and large) were placed based on terrain and visibility. Control markers in open areas were smaller, so they would be more difficult to spot from a distance, while those hung within trees or brush were larger. This placement necessitated student use of the map, rather than merely visual location of control markers. Each control marker was assigned a point value based on difficulty. Ten of the control markers were assigned a value of ten points each, three control markers that were more difficult and/or farther from the start/finish were

valued at twenty points each, while the two most difficult control markers were valued at thirty points each. Students were tasked with accumulating as many points as possible within a 35-minute time limit. Points were accumulated by finding a numbered control marker and using the attached hole punch to punch a unique hole pattern into the box on the scorecard with the corresponding number.

To incentivize students' locating the lower point markers, an extra challenge was added consisting of a keychain (Appendix K) included with one of the 10-point control markers. The purpose of the keychain was to ensure that students did not go only for high point markers. Students were made aware that a keychain existed, but there was no indication on the map of the placement of the keychain. The keychain was worth 40 extra points, and the first dyad to find this keychain could take it and return it to the facilitator at the end of the course, thus receiving the extra 40 points. The keychain was there to encourage students to devise an overall strategy.

Data Collection

Video Capture. Prior to students beginning the orienteering activity, the teacher projected a randomly generated list of student dyads on a screen in the front of the classroom for the students to see when they arrived for class. On this list the dyads randomly selected for data collection were highlighted. One student in each randomly selected dyad volunteered to wear the GoPro® Hero4 camera on his/her head using a head strap and quick clip. The GoPro® Hero4 cameras were used to capture video and audio data during the orienteering experience, which provided the non-formal experience data from the participant's viewpoint. Students were briefly reminded of the rules of the course (Appendix M). They walked outside, found their teammates, and were given one course map (Appendix I) and one scorecard per team (Appendix J). The teacher carried a whistle to notify students of the time limit when five minutes remained in the

experience and again when one minute remained. As soon as all maps and scorecards were handed out, the 35-minute time limit for the course began. Two short blasts from the teacher's whistle notified students when five minutes remained, and one long whistle blast notified students when one minute remained in the time limit.

Post-Interview. Post-interviews occurred in the field directly after the video-recorded dyads completed the course. Student dyads were led to a nearby quiet area where the stationary video cameras were set up, and they answered the eleven questions from the Orienteering Post-Interview Protocol (Appendix N). This process was repeated for dyads in each of the teacher's five classes throughout the day, resulting in ten video-recorded interviews of two students each.

Data Analysis

This study utilized a fully integrated mixed method monostrand conversion design (Teddlie & Tashakkori, 2006), which entails the conversion of qualitative data to quantitative data with analysis and comparison between the qualitative and quantitative data. Multiple phases were utilized to triangulate the qualitative and quantitative data from this study.

To answer RQ1, audio/video recordings collected throughout the orienteering experiences and post-interviews were manually transcribed and entered verbatim into alternating rows of a Microsoft Excel (2014) spreadsheet, utilizing the identical process as the pilot study. Three coders conducted concurrent analysis of each orienteering experience transcript. As with the pilot transcript, each of the coders segmented student utterances based on meaning conveyed and coded each segment utilizing the coding rubric for 21st century skills (Appendix O). Once all coders completed segmentation and coding of a given transcript, they met to arbitrate and assign final codes to each segment. A final code was assigned where agreement of independently coded segments occurred. Where agreement had not occurred, independent coders compared,

discussed, and justified the 21st century codes they assigned to each segment. Coders followed this arbitration process until they reached agreement, generating final protocol data. Multiple arbitrations resulted in a final data set that was readied for use in statistical analysis.

RQ 2 was answered through both conceptual and relational content analysis and corroboration of the orienteering experience and interview data as compared to the seven basic commonalities that foster meaningful learning and form the underlying principles of the non-formal learning process discussed in the literature review. Both the quantitative (descriptive statistics) and qualitative data (coding and other content analysis) were analyzed, seeking relationships between the experience and the principles of a quality non-formal learning experience, while the interviews elicited further explanation of the students' perspectives related to the experience and what they valued.

Quantitative Analysis

Descriptive statistics. Final protocol data were analyzed to generate descriptive statistics, including frequency counts, percentage occurrences, and measures of central tendency. For each coding scheme, individual codes were tallied and percentage occurrences were calculated by dividing the total quantity of codes used for that particular coding category. Percent occurrences were calculated as a means of accounting for protocols of different lengths. This increases the validity of the study and facilitates comparison of differences between dyads. Percentage occurrences were then used to calculate measures of central tendency for each code of each dyad. Percentage frequency distribution specified the percentage of observations that exist for each data point and grouping of data points (Shapiro, 2008).

Qualitative Analysis

Data from the interviews were analyzed qualitatively by interpreting and characterizing student responses, looking for relationships. This analysis consisted of generating natural units of meaning, classifying, categorizing and ordering these units of meaning, structuring narratives to describe the interview contents, and interpreting the interview data (Cohen, Manion & Morrison, 2000). Specifically, qualitative analysis involved counting frequencies of occurrence for words, themes, and pieces of data, noting patterns and themes, clustering items into categories, building a logical chain of evidence through noting causality and making inferences, and making conceptual/theoretical coherence- building constructs and theories to explain the phenomena (Miles & Huberman, 1994). These data were organized in a clustered summary table. Through methods triangulation, the data from the interviews were then corroborated with the orienteering experience qualitative and quantitative data. Methods triangulation combined the descriptive statistics, content analysis, and corroborative analysis of the interview and orienteering experience data to obtain a deeper understanding and further demonstrate concurrent validity. (Denzin, 1978; Patton, 1999).

Summary

This chapter described the purpose and design of this study as it related to the data and analysis. It also described the study participants, materials utilized and the pilot study that informed the purpose and data collection of the study. Data analysis, including specific statistical analysis and triangulation of both qualitative and quantitative data from the orienteering experience and qualitative data from the post-interviews was also included. For detailed description of the development of a viable coding scheme for student acquisition of 21st century

skills, and the iterative process by which intercoder reliability was established, including average pairwise percent agreements (APPA), see Appendix Q.

CHAPTER IV: FINDINGS

This chapter presents the results of data analysis of video recordings from a middle school orienteering experience and post-interview. Quantitative data derived from coding of student utterances recorded during the orienteering experience addresses research question 1, while qualitative data analysis from the post-experience interview addresses research question 2. Mixing of these data occurred at the analysis phase using corroborative data analysis to gain a richer understanding of what characterizes a viable non-formal learning experience.

This chapter opens with a discussion of the main study regarding data sources and establishment of intercoder reliability, followed by a presentation of the quantitative findings of student engagement in 21st century skills and qualitative findings of characteristics of a viable non-formal learning experience. Additionally, statistical and corroborative analysis of research questions is provided.

Main Study

Research Questions

The two research questions that guided this study were:

> RQ#1: To what extent are students engaged in the following 21st century skills while participating in a non-formal learning experience: Learning and Innovation Skills (creativity and innovation, critical thinking, and problem solving), Life and Career Skills (flexibility and adaptability, initiative, self-direction and productivity, and leadership, responsibility and accountability) and Socio-Cultural Skills (communication and collaboration)?
>
> RQ#2: What characterizes a viable non-formal learning experience facilitating student engagement in 21st century skills?

Data Sources

Video recordings of the orienteering experience were transcribed, coded by three independent coders, and arbitrated to establish final codes. This process generated the descriptive statistics necessary to address research question 1. Video recordings of the post-experience interviews were transcribed and qualitatively analyzed through theme analysis. These data were used to address research question 2. Corroboration of both the quantitative and qualitative data analysis further addressed viability of non-formal learning experiences for engagement in 21st century skills, and also resulted in implications for instructional design of non-formal learning experiences.

Pilot Study

A pilot study was conducted to inform the main study and assist in establishing a valid coding scheme and intercoder reliability. Video recordings of a dyad orienteering experience and post-interview were transcribed manually with individual utterances from each dyad member entered verbatim into alternating rows of a spreadsheet. A preliminary coding scheme (Appendix C) was developed utilizing the Framework for 21st Century Learning Definitions of Learning & Innovation Skills and Life & Career Skills (P21, 2015). After comparing it to the pilot study transcript, it became obvious that this coding scheme contained copious overlap, making it unsuitable for establishing inter-coder reliability. The coding scheme was then paired down, and Communication & Cross-Cultural Skills was separated as a third unique category (Socio-Cultural Skills), rather than combined within Learning & Innovation Skills and Life & Career Skills (Appendix D). After comparing it once again to the pilot study transcripts, this coding scheme was sent to a panel of two individuals. Criteria for panelist selection included extensive knowledge of P21, NGSS, and Common Core Standards, previous experience teaching 21st

century skills, experience coding and arbitrating transcripts, and experience in non-formal learning. The panelists were provided with the *P21 Framework Definitions* (P21, 2015) for Learning & Innovation and Life & Career Skills (Appendix E), and a chart of the P21 skills cross-referenced with *Science and Engineering Practices in the NGSS* and *Common Core Standards for Mathematical Practice* MP1, MP2, MP3, MP6, and MP8 (Appendix H). The original coding scheme (Appendix C), pilot study transcripts (Appendix P), and the coding scheme developed for calibration (Appendix D) were also provided. Data were coded using Weber's (1990) eight-step coding protocol (Table 1).

Table 2.

Weber's Eight-Step Coding Protocol (1990)

1. Definition of coding units (e.g., word, phrase, sentence, and paragraph)
2. Definition of coding categories
3. Test of coding on a sample
4. Assessment of the accuracy and reliability of the sample coding
5. Revision of the coding rules
6. Return to step 3 repeatedly until sufficient reliability
7. Coding of all text
8. Assess the achieved reliability or accuracy

The panelists read the P21 definitions and the pared down coding rubric, ensuring that each code and definition were in sync and codes were not redundant. Panelists were asked to make notations about the definitions and suggested modifications. (Appendix F). The panelists and lead researcher then met and reviewed all comments, arbitrating results for each skill. Through this process, the lead researcher developed a newly revised coding scheme (Appendix G).

The panelists then used the refined definitions with the codes to conduct concurrent analysis of 10% of the pilot transcript. This process required panelists to simultaneously divide student utterances until each individual segment contained a single code that reflected only one

of the eight 21st century skills. Once independent coders completed the segmentation and coding with the revised coding scheme, they met to arbitrate all codes. A final code was automatically assigned where 100% agreement of independently coded segments occurred before arbitration. During arbitration, the independent coders compared, discussed, and justified the 21st century codes they assigned to each segment. Segments that differed in assigned codes required coders to engage in arbitration to dispute the assigned coding and reach agreement on the 21st century skill addressed. Independent coders arbitrated until they reached 100% agreement on the final code, necessitating refinement of the coding scheme in some instances.

Co-coders and the lead researcher then individually coded another 10% (approximately 25 lines) of the pilot study transcript using the newly redefined coding scheme. Again, a final code was assigned only when there was 100% agreement among co-coders. All codes without 100% agreement were arbitrated until consensus was reached or the coding scheme was refined to facilitate agreement. The process of coding and arbitrating 10% of the pilot study transcript was then repeated for a third time. The researcher and co-coders again looked for discrepancies within the coding schemes and worked to further clarify assignments of codes. An additional 30% of the pilot transcript was then coded and arbitrated. The researcher and co-coders once again examined the coding schemes, clarified and further developed heuristics for definitions, and then coded and arbitrated the remaining 40% of the pilot study transcript.

The measure of inter-coder reliability validates the interpretation of content and quality of research. It requires independent coders to agree on interpretation of the content based on the coding scheme (Cho, 2008). The percent agreement method, which computed the average pairwise percent agreement (APPA) was used to measure the agreement between coders. To compute this statistic, the average of cases of agreement between coders was calculated by all

possible codes in the final protocol. A percentage agreement above 75% was used as a benchmark for coder consensus within the context of the study. This is deemed an acceptable measure in social sciences (Klenke, 2008; Schloss & Smith, 1999; Stemler, 2004). Inter-coder agreement of the last 40% of the transcript was 76% for the Socio-Cultural coding scheme and 77% for the Learning and Innovation and Life and Career coding scheme. Inter-coder agreement for the entire pilot transcript was 78% for the Socio-Cultural coding scheme and 75% for the Learning and Innovation and Life and Career coding scheme. The iterative process described above resulted in the final coding scheme, heuristics, and example utterances that produced acceptable intercoder agreements for the main study (Appendix O). Further details of this process are included in the pilot study description (Appendix Q).

Data Analysis

Research Question 1

The following tables illustrate student engagement in each of the 21st century skills discussed in Research Question 1. Two separate coding schemes were employed, one for Learning and Innovation Skills and Life and Career Skills, and another for Socio-Cultural Skills. This was necessary, as communication and collaboration were the particular Socio-Cultural Skills examined, and all student utterances could be described as communication. The separate communication and collaboration coding scheme allowed for coding of strictly communication and coding of communication resulting in collaboration. Two dyads per class were video recorded during the learning experience resulting in a total of 10 video recordings. However, due to technical difficulties five recordings were unusable, leaving five viable video recordings that were transcribed and coded. The five coded transcriptions with two coding schemes resulted in data Tables 3 and 4.

Table 3.

Student Percentage of Engagement in Learning & Innovation Skills and Life & Career Skills

	Learning & Innovation Skills				Life & Career Skills			
	CI	CT	PS	Total	FA	ISP	LRA	Total
Dyad 1	1%	31%	11%	43%	8%	36%	13%	57%
Dyad 2	6%	35%	8%	49%	8%	30%	13%	51%
Dyad 3	7%	22%	8%	37%	14%	38%	11%	63%
Dyad 4	4%	24%	4%	32%	9%	43%	16%	68%
Dyad 5	3%	37%	6%	46%	8%	35%	11%	54%

Note. CI= Creativity & Innovation; CT= Critical Thinking; PS= Problem Solving; FA= Flexibility & Adaptability; ISP= Initiative, Self-Direction & Productivity; LRA= Leadership, Responsibility, & Accountability

Learning and innovation skills and life and career skills. The Learning and Innovation Skills and Life and Career Skills component of Research Question 1 asks

> To what extent are students engaged in the following 21st century skills while participating in a non-formal learning experience: Learning and Innovation Skills (creativity and innovation, critical thinking, and problem solving), and Life and Career Skills (flexibility and adaptability, initiative, self-direction and productivity, and leadership, responsibility and accountability)?

The above question was analyzed by calculating the percentage of observed occurrences in which the students were engaged in each skill during the non-formal learning experience. Frequency of individual codes were tallied and percentage occurrences were calculated by dividing the total quantity of codes used for that particular coding category. Percent occurrences were calculated as a means of accounting for protocols of different lengths.

Within Learning and Innovation Skills, critical thinking showed consistently and significantly higher student engagement than creativity and innovation or problem solving. Critical thinking (highlighted in yellow) was clearly the dominant skill across all cases, ranging from 22% to 37%, while student engagement in problem solving skills and creativity and innovation was by comparison fairly minimal. Problem solving skills, ranging from 4% to 11%, showed slightly higher engagement than creativity and innovation, which ranged from 1% to 7%. Within Life and Career Skills, student engagement in initiative, self-direction and productivity (highlighted in blue) far exceeded engagement in leadership, responsibility and accountability or flexibility and adaptability, with student engagement ranging from 30% to 43%. Leadership, responsibility and accountability (11%-16%) was not as distinctly low as flexibility and adaptability, showing a greater contribution to student engagement. Patterns among cases were consistent, and they revealed that during the non-formal learning experience, the 21st century skills with the largest extent of engagement were by far initiative, self-direction and productivity, as well as critical thinking. Students were also engaged in leadership, responsibility and accountability skills, followed by problem solving skills, and flexibility and adaptability. The study revealed that this non-formal learning experience engaged student very little in creativity and innovation. All data sets were fairly consistent in distribution of student engagement, with the largest discrepancy between dyads at 15%.

Table 4.

Student Percentage Engagement in Socio-Cultural Skills

	Socio-Cultural Skills	
	Communication (non-collaborative)	Collaboration
Dyad 1	59%	41%
Dyad 2	47%	53%
Dyad 3	46%	54%
Dyad 4	42%	58%
Dyad 5	47%	53%

Socio-cultural skills. The Socio-Cultural component of Research Question 1 "To what extent are students engaged in the following 21st century skills while participating in a non-formal learning experience: communication and collaboration," was also analyzed by calculating the percentage of observed occurrences in which the students were engaged in each skill during the non-formal learning experience. The data show a relatively even split between communication and collaboration, with four out of the five dyads engaged in collaboration slightly more than communication.

Research Question 2

Research Question 2 "What characterizes a viable non-formal learning experience facilitating student engagement in 21st century skills?" was answered through both conceptual and relational content analysis and corroboration of the orienteering experience and interview data. This was compared to the seven basic commonalities that foster meaningful learning and form the underlying principles of the non-formal learning process discussed in the literature

review. Directly following the non-formal learning experience, each dyad participated in a 5 to15-minute video-recorded interview. The following table characterizes the interview length and dyads.

Table 5.

Characterization of Interviews

Dyad	Time Length	Transcribed Lines	Gender
1	6 minutes 30 seconds	59	M/M
2	7 minutes	70	M/F
3	13 minutes 15 seconds	140	M/M
4	5 minutes 4 seconds	59	M/F
5	8 minutes 47 seconds	145	M/M

Protocol. The researcher transcribed each interview and employed the process of progressive focusing (Parlett & Hamilton, 1976) to sift, sort, review and reflect on the data collected. Through this process, the researcher and a panel member independently analyzed each interview and compared all five interviews simultaneously. After extensive discussion, results were compared and merged, producing one set of dyad interviews with highlights and notations of meaningful units (Appendix R). Each unit, or utterance, was divided based on meaning conveyed. Significant features within each interview emerged, as did noticeable overlaps between interviews. Domain analysis was then conducted, grouping the utterances into clusters, patterns and themes to form domains. Codes were analyzed and concurrently modified as themes emerged. This process assisted the researcher in moving from description to explanation and theory generation (Cohen, Manion & Morrison 2000). Finally, utilizing constant comparison

(Glaser & Strauss, 1967), the researcher compared data that were applicable to each category to data within and across cases that were in the same category, and integrated these categories. Only themes that appeared consistently across all five dyad interviews were retained. (Appendix S). These themes were compared to 21st century skills, setting out a theory of viable characteristics for a non-formal learning experience facilitating student engagement in 21st century skills. The results of this process are presented in Table 6, with exemplar utterances illustrative of the six characteristics of the non-formal learning experience and the 21st century skills that emerged from all five dyad interviews.

Table 6.

Theme Analysis Summary of Viable Non-Formal Learning Characteristics

Theme	Utterance Representative Samples	21st Century Skill	Viable Characteristics	Percent of Utterances
Thinking critically to solve problems	"Uh, when we had a problem, we kinda looked at the map closer and closer, to see like where this road was like the curve and stuff. So say there's like, I guess all those trees and we'd look at the curve just to know exactly where it was." (Dyad 4, p. 4) "…we had to sort of accept and understand that they are there. They're not like mislabeled. Cause it got, sometimes it got a little frustrating cause we'd be like 'we're right here'" (Dyad 2, p. 3)	Critical thinking Problem solving	Foster integration of skills and knowledge to solve problems	17%
Making decisions, scaffolding	"…each time we got one we were like, alright, we can get this one, we can get this one each time, so that's what we did, like help us push on and get our…" (Dyad 5, p.5) "So after we got the ones that, after we got the two that were down here, we cut up the field and we were sitting in the middle of the field talking and we were like, alright, I know we missed number 15, but I think we should go back and try to find that because it might help us out with points since, uh, more points the better, and we both agreed on it so" (Dyad 5, p. 6)	Initiative, self-direction, productivity Leadership, responsibility, accountability	Embolden the student to be an active, autonomous, self-regulated decision-maker	13%

Table 6. (cont.)

Theme Analysis Summary of Viable Non-Formal Learning Characteristics

Theme	Utterance Representative Samples	21st Century Skill	Viable Characteristics	Percent of Utterances
Authentic collaboration	A:/ "In group work, you need teamwork, and I mean the teachers can tell you to work" B:/ "Together" A:/ "To work together but that's not gonna- they can't make you and when you're" B:/ "This is fun so…" A:/ "When you're doing something that's fun, but also challenging" B:/ "You want to work" A:/ "Yeah you want to work together and it teaches good teamwork" (Dyad 2, p.1-2) "…I'd point, he'd run over there, stamp it and I'd still try to figure out where the map was going." (Dyad 4, p.2)	Collaboration Communication	Support collaborative construction of knowledge	27%
Motivation	A:/ "When you're doing something that's fun, but also challenging" B:/ "You want to work" (Dyad 2, p.4) "It's like recess with hidden learning" (Dyad 2, p.7)	Initiative, self-direction and productivity	Meaningful activities within the context of an authentic learning environment	13%
Evaluation, flexibility	"Sometimes on the way, you realize that you are not pinpoint where you think you are, so you'd have to" A:/ "Yeah we'd be running and he'd be like..." B:/ "So if you're running one direction and you thought you were running the other direction to get one then it kinda changes of how you do throughout the map" A:/ "It really changes" (Dyad 3, p. 1-2)	Flexibility and adaptability Critical thinking	Continuous formative and authentic assessment within tasks	21%

Table 6. (cont.)

Theme Analysis Summary of Viable Non-Formal Learning Characteristics

Theme	Utterance Representative Samples	21st Century Skill	Viable Characteristics	Percent of Utterances
Self-reflection, intrinsic positive reinforcement building skill/ knowledge	"Actually it's a little bit easier than it looks because the map can be a little bit confusing but once you get the hang of where the bird's eye view is, like how far apart things are from each other then it gets a lot easier to move to the different points" (Dyad 3, p.5)	Communication Critical Thinking Problem Solving	Reflection and articulation to foster the formation of abstractions and enable tacit knowledge to become explicit	9%

Throughout the process of analyzing each dyad interview, several common themes repeatedly emerged. Students consistently discussed how they worked as a team to make decisions collaboratively, how they constantly evaluated and re-evaluated their decisions and strategies based on their progress and level of success throughout the non-formal learning activity, and the critical thinking processes they used to solve problems. Additionally, every dyad discussed the positive nature of communication and collaboration throughout the experience, some even highlighting how the specific non-formal learning environment fosters this effort, for example, "When you're doing something fun and also challenging…you want to work together, and it teaches good teamwork." Initiative, self-direction, and productivity were evident through the interviews, with incremental student successes discussed as scaffolds to build the knowledge and confidence necessary to support further problem solving within the experience. One dyad described this scaffolding and initiative as "Each time we got one we were like, alright, we can get this one…like help us push on…" There was no mention of any teacher or facilitator providing answers or direct assistance in any interview. Conversely, every interview discussed abundant student-made decisions and problem solving. Phrases in student interviews such as "…the map can be a little bit confusing but once you get the hang of where the bird's eye view is, like how far apart things are from each other then it gets a lot easier to move to the different points" are illustrative of student learning independent of teacher-directed instruction.

The only 21st century skill not consistently evident in all five dyad interviews was creativity and innovation. Two of the five dyads asserted that a strategy they employed was especially creative or inventive, for example, "…to stay behind the tree line, because we could've hopped on the bandwagon just kind of gone through and out the trees but we decided it was

getting a little scraped up, we were getting a little scraped up..." but three of the dyads could not come up any engagement creativity or inventiveness.

As exemplified in Table 5, student descriptions of their experiences while participating in the learning activity show consistent alignment with what P21 characterizes as 21st century Learning and Innovation, Life and Career, and Socio-Cultural Skills, excluding creativity and innovation. Six of the seven basic commonalities that foster meaningful learning and form the underlying principles of the non-formal learning process were also discussed in the five dyad interviews (Viable Characteristics column). The seventh characteristic, the role of the teacher as facilitator, was also evident throughout student descriptions of their learning. This role is apparent as there was no mention of teacher intervention in any of the interviews, rather, students consistently described how they took the initiative to collaborate, think critically, and problem solve, consistently figuring out difficult situations for themselves, without direct teacher intervention.

The researcher revisited the learning experience transcripts to match student responses in interviews to observed behaviors, looking for any disconfirming cases as well as confirmation of student descriptions. Learning experience transcripts corroborated student interview utterances, as each of the five dyads described experiences in the interview that were directly found in each of the experience transcripts. Learning experience data analysis also corroborated the findings of the student interview, with heavy emphasis on collaboration and communication as well as critical thinking skills and initiative, self-direction and productivity. Leadership, responsibility, and accountability, problem solving, and flexibility and adaptability were found to a lesser extent, but were described in all five dyad interviews as well as the learning experience data analysis. While use of creativity and innovation was a direct question in the interviews, students

could recall little or no use of it during the learning experience. This was supported by the learning experience transcripts, as creativity and innovation only accounted for between 1% and 7% of student utterances.

Summary of Findings

After utilizing the pilot study to inform the research and develop a coding scheme with intercoder reliability, quantitative data analysis findings derived from coded transcripts of the non-formal learning experience were presented in chapter 4 to answer Research Question 1. Qualitative analysis findings of student post-interview transcripts were presented to answer Research Question 2. Descriptive statistics, content analysis, and corroborative analysis of the interview and orienteering experience data were utilized to obtain a deeper understanding and further demonstrate concurrent validity.

According to the five coded transcripts of the non-formal learning experience, 21st century skills with highest student engagement by far were critical thinking and initiative, self-direction and productivity. Qualitative analysis of the post-experience interviews corroborates these findings, as all five dyads consistently discuss multiple engagements in these skills. Specific elaboration of critical thinking was characterized in student discussions of how they utilized various types of reasoning, analysis, synthesis, and critical reflection to solve problems as they came about. Discussion of initiative, self-direction and productivity was also abundant in the post-experience interviews. In each interview, students discussed how they balanced tactical goals with strategic goals, and monitored, defined, and prioritized tasks. They re-evaluated their prioritizations (critical thinking) throughout the experience, and changed priorities as needed (flexible thinking). Students described how they set goals for success, even in the face of obstacles and managed the tasks to gain the most points in the least amount of time. Student

engagement in productivity was also evident in the post-interviews through students' discussion of how they managed their time to most efficiently complete tasks.

Leadership, responsibility and accountability, with student engagement between 11% and 16% during the learning experience, was evidenced in the interviews through student descriptions of how they leveraged their strengths and the strengths of their teammates to accomplish their common goals. Ethical behavior was also evident throughout, with dyads even helping other teams through difficulties, and students clearly held themselves accountable for results. There was little evidence of creativity and innovation in the post-experience interview, even though students were specifically asked about it. Creativity and innovation accounted for the least amount of engagement (between 1% and 4%) during the learning experience.

Quantitative learning experience data determined between 41% and 58% student engagement in collaboration during the experience. Students identified these skills within the post-experience interview through utterances such as "I think it was a good exercise in building teamwork skills and cooperation, and respect toward your partner's decisions" and "I'd point, he'd run over there, stamp it and I'd still try to figure out where the map was going." Students characterized collaboration as both aiding problem solving (leveraging each other's strengths) and assisting in completing tasks more quickly.

While engagement in initiative, self-direction and productivity, critical thinking skills, and communication and collaboration clearly dominated the non-formal learning experience, students also showed engagement in leadership, responsibility and accountability, problem solving, flexibility and adaptability, with a very small percentage of engagement in creativity and innovation. Copious student cognitive engagement in these 21st century Learning and Innovation Skills, Life and Career Skills and Socio-Cultural Skills, excluding creativity and innovation, was

evident, and the viability of the non-formal learning experience was clearly characterized through student articulation of this engagement.

CHAPTER V: CONCLUSIONS, IMPLICATIONS, AND RECOMMENDATIONS

This chapter discusses conclusions, implications, and recommendations derived from the research. Conclusions are based on findings from data analysis as presented in the previous chapter, and focus on answering the two research questions. Implications resulting from these conclusions are presented for future research and practice, followed by recommendations for application of these findings to research and practice. Recognizing the inherent limitations of this research, the following conclusions, implications, and recommendations are presented below.

Research Question 1

> To what extent are students engaged in the following 21st century skills while participating in a non-formal learning experience: Learning and Innovation (creativity and innovation, critical thinking, problem solving), Life and Career (flexibility and adaptability, initiative, self-direction and productivity, leadership, responsibility and accountability) and Socio-Cultural (communication and collaboration)?

The above question was answered through analyses of data collected in video-recordings of students participating in a 35-minute orienteering experience. What follows are conclusions drawn from this analysis.

Conclusions: Learning and Innovation Skills. Within Learning and Innovation Skills, one can conclude that this orienteering experience is extremely effective for engaging students in critical thinking (Table 3, p. 52). One can also conclude that several steps of critical thinking are necessary to move toward each problem solution (PS). From this data it can also be concluded that this orienteering experience was not very conducive to student engagement in creativity and innovation (CI).

Conclusions: Life and Career Skills. From these data, it can be concluded that as designed, this orienteering experience is a very strong instructional approach for engaging students in initiative, self-direction and productivity (ISP) (Table 3, p.52). It can also be concluded that students marginally engage in the 21st century skills of leadership, responsibility and accountability (LRA) through this experience.

While flexibility and adaptability (FA) comprised a small part of total overall engagement, its existence is important to the findings of this study. These skills were demonstrated consistently across all five dyad experiences and corroborated in the interviews (Table 6, p.57).

Conclusions: Socio-Cultural Skills. Based on the data (Table 4, p. 54), it can be concluded that the design of this non-formal instruction (task interdependence requiring teammates to rely on each other to solve problems) leads to high student engagement in collaboration.

Research Question 2

The second research question in the study, "What characterizes a viable non-formal learning experience facilitating student engagement in 21st century skills?" was answered through qualitative analysis of data from the post-experience interviews. The findings from analysis of the interviews corroborated the findings from analysis of the learning experience.

Conclusions: Characteristics of Viable Non-Formal Learning Experiences. From analysis of student interviews, it can be concluded that the following characteristics reflect a viable non-formal learning experience. The experience is characterized as one that fosters integration of skills and knowledge to solve problems, emboldens students to be active, autonomous, self-regulated decision-makers, supports collaborative construction of knowledge,

provides meaningful activities within the context of an authentic learning environment, includes continuous formative and authentic assessment within tasks, and encourages reflection and articulation to foster the formation of abstractions and enable tacit knowledge to become explicit (Table 6, p. 57).

Summary of Conclusions

Based on findings as presented in Chapter IV, the following main conclusions were reached.

1. This particular non-formal learning experience was strong in engaging students in collaboration, critical thinking and initiative, self-direction and productivity. It also engages students in leadership, responsibility and accountability, problem solving, and to a lesser extent, flexibility and adaptability.
2. This particular non-formal learning experience was not strong in engaging students in creativity and innovation.
3. A viable non-formal learning experience is characterized as one that fosters integration of skills and knowledge to solve problems, emboldens students to be active, autonomous, self-regulated decision-makers, supports collaborative construction of knowledge, provides meaningful activities within the context of an authentic learning environment, includes continuous formative and authentic assessment within tasks, and encourages reflection and articulation to foster the formation of abstractions and enable tacit knowledge to become explicit.

Implications

The conclusions reached in this study reveal the following set of specific implications for researchers, educators, administrators, and teacher educators.

1. Given this study found non-formal learning to be a viable approach for engaging students in 21st century skills, the implications are that there now exists a potential avenue for exploring the measurement of non-domain specific engagement in 21st century skills. Measurement of non-domain specific skills would complement the current measurement of domain-specific skill as assessed in Common Core State Standards and Next Generation Science Standards, and ultimately situate non-formal learning as a parallel instructional approach to that of traditional formal learning.
2. This study revealed that students were consistently engaged in the same non-domain specific 21st century skills targeted in Common Core State Standards and Next Generation Science Standards, therefore the implications are that non-formal learning is a pathway for achieving current educational initiatives and a viable use of student instructional time. Focusing instructional time on non-formal learning both within the formal school day and outside of it are valuable means for achieving current educational initiatives.
3. As students were engaged in the specific 21st century skills that this particular non-formal learning activity was intentionally designed to foster, the implication exists that instructional design for non-formal learning deliberately target certain non-domain specific skills. Existing non-formal learning activities can be adjusted to more fully engage students in targeted non-domain specific 21st century skills, and new learning opportunities can be designed with these specific goals in mind.

Recommendations

Based on the implications of this study, the following actions are recommended for researchers, educators, administrators, and teacher educators.

Recommendations for Researchers

The following recommendations for further research resulted from the findings and conclusions of this study.

1. Further research should be conducted studying non-formal learning experiences with larger populations and a variety of demographics and age groups.
2. Research should be conducted to determine whether working in dyads or larger groups more effectively fosters engagement in 21st century skills.
3. Research should be conducted to determine how longer and/or more challenging experiences would affect the outcomes.
4. Both single-gender and mixed-gender groups should be studied to determine if there are gender-based differences in engagement in 21st century skills through non-formal learning.

Recommendations for Practitioners

The following recommendations for teacher educators, supervisors/administrators, and formal and non-formal educators were generated by the findings and conclusions of this study.

1. Professional development for formal educators in how to design and implement non-formal learning instruction to engage students in 21st century skills should be provided.
2. Professional development for non-formal educators in how to better incorporate standards such as Common Core, NGSS, and P21 into their teaching should be provided.
3. Practitioners should integrate non-formal learning practices into the formal school instruction.
4. Practitioners should design instruction with specific 21st century skills in mind.

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APPENDIX A

IRB Approval Letter (Pilot Study)

Office of Research Compliance
Institutional Review Board
North End Center, Suite 4120, Virginia Tech
300 Turner Street NW
Blacksburg, Virginia
24061 540/231-4606
Fax 540/231-0959
email irb@vt.edu
website http://www.irb.vt.edu

MEMORANDUM

DATE: June 22, 2015

TO: John Wells, Lisa Ann Moyer

FROM: Virginia Tech Institutional Review Board (FWA00000572, expires April 25, 2018)

PROTOCOL TITLE: Problem Solving Metacognition though Orienteering

IRB NUMBER: **15-603**

Effective June 22, 2015, the Virginia Tech Institution Review Board (IRB) Chair, David M Moore, approved the New Application request for the above-mentioned research protocol.

This approval provides permission to begin the human subject activities outlined in the IRB-approved protocol and supporting documents.

Plans to deviate from the approved protocol and/or supporting documents must be submitted to the IRB as an amendment request and approved by the IRB prior to the implementation of any changes, regardless of how minor, except where necessary to eliminate apparent immediate hazards to the subjects. Report within 5 business days to the IRB any injuries or other unanticipated or adverse events involving risks or harms to human research subjects or others.

All investigators (listed above) are required to comply with the researcher requirements

outlined at: http://www.irb.vt.edu/pages/responsibilities.htm

(Please review responsibilities before the commencement of your research.)

PROTOCOL INFORMATION:

Approved As:	**Expedited, under 45 CFR 46.110 category(ies) 5,6,7**
Protocol Approval Date:	**June 22, 2015**
Protocol Expiration Date:	**June 21, 2016**
Continuing Review Due Date*:	**June 7, 2016**

*Date a Continuing Review application is due to the IRB office if human subject activities covered under this protocol, including data analysis, are to continue beyond the Protocol Expiration Date.

FEDERALLY FUNDED RESEARCH REQUIREMENTS:

Per federal regulations, 45 CFR 46.103(f), the IRB is required to compare all federally funded grant proposals/work statements to the IRB protocol(s) which cover the human research activities included in the proposal / work statement before funds are released. Note that this requirement does not apply to Exempt and Interim IRB protocols, or grants for which VT is not the primary awardee.

The table on the following page indicates whether grant proposals are related to this IRB protocol, and which of the listed proposals, if any, have been compared to this IRB protocol, if required.

Date*	OSP Number	Sponsor	Grant Comparison Conducted?

* Date this proposal number was compared, assessed as not requiring comparison, or comparison information was revised.

If this IRB protocol is to cover any other grant proposals, please contact the IRB office (irbadmin@vt.edu) immediately.

APPENDIX B

IRB Approval Letter (Actual Study)

Office of Research Compliance
Institutional Review Board
North End Center, Suite 4120, Virginia Tech
300 Turner Street NW
Blacksburg, Virginia
24061 540/231-4606
Fax 540/231-0959
email irb@vt.edu
website http://www.irb.vt.edu

MEMORANDUM

DATE: September 24, 2015

TO: John Wells, Lisa Ann Moyer

FROM: Virginia Tech Institutional Review Board (FWA00000572, expires July 29, 2020)

PROTOCOL TITLE: Developing 21st Century Skills through Informal Learning Experiences

IRB NUMBER: **15-692**

Effective September 23, 2015, the Virginia Tech Institution Review Board (IRB) Chair, David M Moore, approved the New Application request for the above-mentioned research protocol.

This approval provides permission to begin the human subject activities outlined in the IRB-approved protocol and supporting documents.

Plans to deviate from the approved protocol and/or supporting documents must be submitted to the IRB as an amendment request and approved by the IRB prior to the implementation of any changes, regardless of how minor, except where necessary to eliminate apparent immediate hazards to the subjects. Report within 5 business days to the IRB any injuries or other unanticipated or adverse events involving risks or harms to human research subjects or others.

All investigators (listed above) are required to comply with the researcher requirements

outlined at: http://www.irb.vt.edu/pages/responsibilities.htm

(Please review responsibilities before the commencement of your research.)

PROTOCOL INFORMATION:

Approved As:	**Expedited, under 45 CFR 46.110 category(ies) 6,7**
Protocol Approval Date:	**September 23, 2015**
Protocol Expiration Date:	**September 22, 2016**
Continuing Review Due Date*:	**September 8, 2016**

*Date a Continuing Review application is due to the IRB office if human subject activities covered under this protocol, including data analysis, are to continue beyond the Protocol Expiration Date.

FEDERALLY FUNDED RESEARCH REQUIREMENTS:

Per federal regulations, 45 CFR 46.103(f), the IRB is required to compare all federally funded grant proposals/work statements to the IRB protocol(s) which cover the human research activities included in the proposal / work statement before funds are released. Note that this requirement does not apply to Exempt and Interim IRB protocols, or grants for which VT is not the primary awardee.

The table on the following page indicates whether grant proposals are related to this IRB protocol, and which of the listed proposals, if any, have been compared to this IRB protocol, if required.

Date*	OSP Number	Sponsor	Grant Comparison Conducted?

* Date this proposal number was compared, assessed as not requiring comparison, or comparison information was revised.

If this IRB protocol is to cover any other grant proposals, please contact the IRB office (irbadmin@vt.edu) immediately.

APPENDIX C

P21 Skills Coding Scheme (Original)

Category	Code	Definition
Learning and Innovation Skills		
Creativity and Innovation	**CI**	
Think Creatively	**CI-TC**	• use a wide range of idea creation techniques (such as brainstorming) • Create new and worthwhile ideas (both incremental and radical concepts) • Elaborate, refine, analyze and evaluate their own ideas in order to improve and maximize creative efforts.
Work Creatively with Others	**CI-CO**	• Develop, implement and communicate new ideas to others effectively • Be open and responsive to new and diverse perspectives; incorporate group input and feedback into the work • Demonstrate originality and inventiveness in work and understand the real world limits to adopting new ideas. • View failure as an opportunity to learn; understand that creativity and innovation is a long-term, cyclical process of small success and frequent mistakes
Implement Innovations	**CI-II**	• Act on creative ideas to make a tangible and useful contribution to the field in which the innovation will occur
Critical Thinking and Problem Solving	**TPS**	
Reason Effectively	**TPS-R**	• Use various types of reasoning (inductive, deductive, etc.) as appropriate to the situation
Use Systems Thinking	**TPS-S**	• Analyze how parts of a whole interact with each other to produce overall outcomes in a complex system
Make Judgements and Decisions	**TPS-D**	• Effectively analyze and evaluate evidence, arguments, claims and beliefs • Analyze and evaluate major alternative points of view • Synthesize and make connections between information and arguments • Interpret information and draw conclusions based on the best analysis

		• Reflect critically on learning experiences and processes
Solve Problems:	**TPS-P**	• Solve different kinds of non-familiar problems in both conventional and innovative ways • Identify and ask significant questions that clarify various points of view and lead to better solutions
Communication and Collaboration	**CC**	
Communicate Clearly	**CC-CC**	• Articulate thoughts and ideas effectively using oral, written and nonverbal communication skills in a variety of forms and contexts • Listen effectively to decipher meaning, including knowledge, values, attitudes and intentions • Use communication for a range of purposes (e.g. to inform, instruct, motivate and persuade) • Utilize multiple media and technologies, and know how to judge their effectiveness a priori as well as assess their impact • Communicate effectively in diverse environments (including multi-lingual)
Collaborate with Others	**CC-CO**	• Demonstrate ability to work effectively and respectfully with diverse teams • Exercise flexibility and willingness to be helpful in making necessary compromises to accomplish a common goal • Assume shared responsibility for collaborative work, and value the individual contributions made by each team member
Life and Career Skills		
Flexibility and Adaptability	**FA**	
Adapt to Change	**FA-A**	• Adapt to varied roles, jobs responsibilities, schedules and contexts • Work effectively in a climate of ambiguity and changing priorities
Be Flexible	**FA-F**	• Incorporate feedback effectively • Deal positively with praise, setbacks and criticism • Understand, negotiate and balance diverse views and beliefs to reach workable solutions, particularly in multi-cultural environments
Initiative and Self-Direction	**ISD**	
Manage Goals and Time	**ISD-M**	• Set goals with tangible and intangible success criteria

		• Balance tactical (short-term) and strategic (long-term) goals • Utilize time and manage workload efficiently
Work Independently	**ISD-WI**	• Monitor, define, prioritize and complete tasks without direct oversight
Be Self-directed Learners	**ISD-SD**	• Go beyond basic mastery of skills and/or curriculum to explore and expand one's own learning and opportunities to gain expertise • Demonstrate initiative to advance skill levels towards a professional level • Demonstrate commitment to learning as a lifelong process • Reflect critically on past experiences in order to inform future progress
Social and Cross-Cultural Skills	**SCS**	
Interact Effectively with Others:	**SCS-IO**	• Know when it is appropriate to listen and when to speak • Conduct themselves in a respectable, professional manner
Work Effectively in Diverse Teams	**SCS-DT**	• Respect cultural differences and work effectively with people from a range of social and cultural backgrounds • Respond open-mindedly to different ideas and values • Leverage social and cultural differences to create new ideas and increase both innovation and quality of work
Productivity and Accountability	**PA**	
Manage Projects	**PA-P**	• Set and meet goals, even in the face of obstacles and competing pressures • Prioritize, plan and manage work to achieve intended results
Produce Results	**PA-R**	• Demonstrate additional attributes associated with producing high quality products including the abilities to: - Work positively and ethically - Manage time and projects effectively - Multi-task - Participate actively, as well as be reliable and punctual

		- Present oneself professionally and with proper etiquette - Collaborate and cooperate effectively with teams - Respect and appreciate team diversity • - Be accountable for results
Leadership and Responsibility	**LR**	•
Guide and Lead Others	**LR-LO**	• Use interpersonal and problem-solving skills to influence and guide others toward a goal • Leverage strengths of others to accomplish a common goal • Inspire others to reach their very best via example and selflessness • Demonstrate integrity and ethical behavior in using influence and power
Be Responsible to Others	**LR-RO**	• Act responsibly with the interests of the larger community in mind

APPENDIX D

Revised Coding Scheme for Panelists' Review

CATEGORY	CODE	DEFINITION
Learning and Innovation Skills		
Creativity and Innovation	CI	• Use a wide range of creation techniques • Demonstrate originality and inventiveness in work and understand the real world limits to adopting new ideas • Create new and worthwhile ideas (both incremental and radical concepts) • Act on creative ideas to make a tangible and useful contribution to the field in which the innovation will occur
Critical Thinking and Problem Solving	TPS	
Critical Thinking	TPS-C	• Use various types of reasoning (inductive, deductive, etc.) as appropriate to the situation • Effectively analyze and evaluate evidence, arguments, claims and beliefs • Analyze how parts of a whole interact with each other to produce overall outcomes in a complex system (systems thinking) • Reflect critically on learning experiences and processes
Make Judgements and Decisions	TPS-D	• Analyze and evaluate major alternative points of view • Synthesize and make connections between information and arguments Interpret information and draw conclusions based on the best analysis
Problem Solving	TPS-P	• Solve different kinds of non-familiar problems in both conventional and innovative ways • Identify and ask significant questions that clarify various points of view and lead to better solutions
Communication and Collaboration/Social and Cultural Skills	CS	
Communication/Social Skills (Take out ALL of this? Everything they do involves communication)	CS-CS	• Articulate thoughts and ideas effectively using oral, written and nonverbal communication skills in a variety of forms and contexts • Listen effectively to decipher meaning, including knowledge, values, attitudes and intentions

		• Use communication for a range of purposes (e.g. to inform, instruct, motivate and persuade) • Interact effectively with others • Communicate effectively in diverse environments (including multi-lingual) • Know when it is appropriate to listen and when to speak • Conduct themselves in a respectable, professional manner • Present oneself professionally and with proper etiquette • communicate new ideas to others effectively
Collaboration	CS-CL	• Be open and responsive to new and diverse perspectives; incorporate group input and feedback into the work • Assume shared responsibility for collaborative work, and value the individual contributions made by each team member • Work effectively in diverse teams • Respect cultural differences and work effectively with people from a range of social and cultural backgrounds • Respond open-mindedly to different ideas and values • Collaborate and cooperate effectively with teams
Life and Career Skills		•
Flexibility and Adaptability	FA	• Adapt to varied roles, jobs responsibilities, schedules and contexts • Work effectively in a climate of ambiguity and changing priorities • Incorporate feedback effectively • Reflect critically on past experiences in order to inform future progress • Deal positively with praise, setbacks and criticism • Exercise flexibility and willingness to be helpful in making necessary compromises to accomplish a common goal • View failure as an opportunity to learn; understand that creativity and innovation is a long-term, cyclical process of small success and frequent mistakes

Initiative and Self-Direction	ISD	• Set goals with tangible and intangible success criteria • Balance tactical (short-term) and strategic (long-term) goals • Go beyond basic mastery of skills and/or curriculum to explore and expand one's own learning and opportunities to gain expertise • Set and meet goals, even in the face of obstacles and competing pressures Prioritize, plan and manage work to achieve intended results
Productivity and Accountability (Manage Projects and Produce Results)	PA	• Multi-task • Be accountable for results
Leadership and Responsibility	LR	• Use interpersonal and problem-solving skills to influence and guide others toward a goal • Leverage strengths of others to accomplish a common goal • Inspire others to reach their very best via example and selflessness • Demonstrate integrity and ethical behavior in using influence and power • Act responsibly with the interests of the larger community in mind

APPENDIX E

P21 Framework for 21st Century Learning

LEARNING AND INNOVATION SKILLS

Learning and innovation skills increasingly are being recognized as those that separate students who are prepared for a more and more complex life and work environments in the 21st century, and those who are not. A focus on creativity, critical thinking, communication and collaboration is essential to prepare students for the future.

CREATIVITY AND INNOVATION

Think Creatively

- Use a wide range of idea creation techniques (such as brainstorming)
- Create new and worthwhile ideas (both incremental and radical concepts)
- Elaborate, refine, analyze and evaluate their own ideas in order to improve and maximize creative efforts

Work Creatively with Others

- Develop, implement and communicate new ideas to others effectively
- Be open and responsive to new and diverse perspectives; incorporate group input and feedback into the work
- Demonstrate originality and inventiveness in work and understand the real world limits to adopting new ideas
- View failure as an opportunity to learn; understand that creativity and innovation is a long-term, cyclical process of small successes and frequent mistakes

Implement Innovations

- Act on creative ideas to make a tangible and useful contribution to the field in which the innovation will occur

CRITICAL THINKING AND PROBLEM SOLVING

Reason Effectively

- Use various types of reasoning (inductive, deductive, etc.) as appropriate to the situation

Use Systems Thinking

- Analyze how parts of a whole interact with each other to produce overall outcomes in complex systems

Make Judgments and Decisions

- Effectively analyze and evaluate evidence, arguments, claims and beliefs
- Analyze and evaluate major alternative points of view
- Synthesize and make connections between information and arguments
- Interpret information and draw conclusions based on the best analysis
- Reflect critically on learning experiences and processes

Solve Problems

- Solve different kinds of non-familiar problems in both conventional and innovative ways
- Identify and ask significant questions that clarify various points of view and lead to better solutions

COMMUNICATION AND COLLABORATION

Communicate Clearly

- Articulate thoughts and ideas effectively using oral, written and nonverbal communication skills in a variety of forms and contexts
- Listen effectively to decipher meaning, including knowledge, values, attitudes and intentions
- Use communication for a range of purposes (e.g. to inform, instruct, motivate and persuade)
- Utilize multiple media and technologies, and know how to judge their effectiveness a priori as well as assess their impact
- Communicate effectively in diverse environments (including multi-lingual)

Collaborate with Others

- Demonstrate ability to work effectively and respectfully with diverse teams
- Exercise flexibility and willingness to be helpful in making necessary compromises to accomplish a common goal
- Assume shared responsibility for collaborative work, and value the individual contributions made by each team member

LIFE AND CAREER SKILLS

Today's life and work environments require far more than thinking skills and content knowledge. The ability to navigate the complex life and work environments in the globally competitive information age requires students to pay rigorous attention to developing adequate life and career skills.

FLEXIBILITY AND ADAPTABILITY

Adapt to Change

- Adapt to varied roles, jobs responsibilities, schedules and contexts
- Work effectively in a climate of ambiguity and changing priorities

Be Flexible

- Incorporate feedback effectively
- Deal positively with praise, setbacks and criticism
- Understand, negotiate and balance diverse views and beliefs to reach workable solutions, particularly in multi-cultural environments

INITIATIVE AND SELF-DIRECTION

Manage Goals and Time

- Set goals with tangible and intangible success criteria
- Balance tactical (short-term) and strategic (long-term) goals
- Utilize time and manage workload efficiently

Work Independently

- Monitor, define, prioritize and complete tasks without direct oversight

Be Self-directed Learners

- Go beyond basic mastery of skills and/or curriculum to explore and expand one's own learning and opportunities to gain expertise
- Demonstrate initiative to advance skill levels towards a professional level
- Demonstrate commitment to learning as a lifelong process
- Reflect critically on past experiences in order to inform future progress

SOCIAL AND CROSS-CULTURAL SKILLS

Interact Effectively with Others

- Know when it is appropriate to listen and when to speak
- Conduct themselves in a respectable, professional manner

Work Effectively in Diverse Teams

- Respect cultural differences and work effectively with people from a range of social and cultural backgrounds
- Respond open-mindedly to different ideas and values
- Leverage social and cultural differences to create new ideas and increase both innovation and quality of work

PRODUCTIVITY AND ACCOUNTABILITY

Manage Projects

- Set and meet goals, even in the face of obstacles and competing pressures
- Prioritize, plan and manage work to achieve the intended result

Produce Results

- Demonstrate additional attributes associated with producing high quality products including the abilities to:
    - Work positively and ethically
    - Manage time and projects effectively
    - Multi-task
    - Participate actively, as well as be reliable and punctual
    - Present oneself professionally and with proper etiquette
    - Collaborate and cooperate effectively with teams
    - Respect and appreciate team diversity
    - Be accountable for results

LEADERSHIP AND RESPONSIBILITY

Guide and Lead Others

- Use interpersonal and problem-solving skills to influence and guide others toward a goal
- Leverage strengths of others to accomplish a common goal
- Inspire others to reach their very best via example and selflessness
- Demonstrate integrity and ethical behavior in using influence and power

Be Responsible to Others

- Act responsibly with the interests of the larger community in mind

APPENDIX F

Panelists Comments on Coding Scheme

Category	1. Need to modify? (yes/no)	If yes, how would you modify?	2. Need to modify? (yes/no)	If yes, how would you modify?
Learning and Innovation Skills				
Creativity and Innovation	No		No	
Critical Thinking and Problem Solving				
Critical Thinking	No		yes	I would combine all three sub-categories of TPS – they are very similar and all represent parts of the non-linear problem-solving process.
Making Judgements and Decisions	No		yes	
Problem Solving	No		yes	
Communication and Collaboration/ Social and Cultural Skills				
Communication /Social Skills	Yes	Include only: • Articulate thoughts and new ideas effectively using oral, written and nonverbal communication skills in a variety	yes	Everything involves communication – drop this category.

		of forms and contexts • Listen effectively to decipher meaning, including knowledge, values, attitudes and intentions		
Collaboration	No		Maybe?	Will these concepts be captured in the participants' statements?
Life and Career Skills				
Flexibility and Adaptability	No		no	
Initiative and Self-Direction	Yes	Add: • Monitor, define, prioritize and complete tasks without direct oversight	no	(add productivity)
Productivity and Accountability	Yes	Add: • Manage time and projects effectively	yes	I think productivity would fit better under self-direction. If they choose to multi-task, that should fit in with their goal. Accountability is totally different – I think it should go with leadership and responsibility
Leadership and Responsibility	No		no	(add accountability)

APPENDIX G

Coding Scheme 1 and 2 (First Iteration with Panelists)

Coding Scheme 1			
CATEGORY	CODE	DEFINITION	Example Utterances
Communication/ Social Skills	1	• Articulate thoughts and ideas effectively using oral, written and nonverbal communication skills in a variety of forms and contexts • Listen effectively to decipher meaning, including knowledge, values, attitudes and intentions • Use communication for a range of purposes (e.g. to inform, instruct, motivate and persuade) • Communicate effectively in diverse environments (including multi-lingual) • Know when it is appropriate to listen and when to speak • Conduct themselves in a respectable, professional manner • Present oneself professionally and with proper etiquette • communicate new ideas to others effectively	
Collaboration	2	• Be open and responsive to new and diverse perspectives; incorporate group input and feedback into the work • Assume shared responsibility for collaborative work, and value the individual contributions made by each team member • Work effectively in diverse teams • Respect cultural differences and work effectively with people from a range of social and cultural backgrounds • Respond open-mindedly to different ideas and values • Collaborate and cooperate effectively with teams	

Coding Scheme 2			
CATEGORY	CODE	DEFINITION	Example Utterances
Learning and Innovation Skills			
Creativity and Innovation	CI	• Use a wide range of creation techniques • Demonstrate originality and inventiveness in work and understand the real world limits to adopting new ideas • Create new and worthwhile ideas (both incremental and radical concepts) Act on creative ideas to make a tangible and useful contribution to the field in which the innovation will occur	
Critical Thinking	CT	• Use various types of reasoning (inductive, deductive, etc.) as appropriate to the situation • Effectively analyze and evaluate evidence, arguments, claims and beliefs and major alternative points of view • Analyze how parts of a whole interact with each other to produce overall outcomes in a complex system (systems thinking) • Synthesize and make connections between information and arguments • Reflect critically on learning experiences and processes	Analyzing what we're doing "…because it's closer"
Problem Solving	PS	• Interpret information and draw conclusions based on the best analysis • Solve different kinds of non-familiar problems in both conventional and innovative ways • Identify and ask significant questions that clarify various points of view and lead to better solutions	
Life and Career Skills		•	
Flexibility and Adaptability	FA	• Adapt to varied roles, jobs responsibilities, schedules and contexts • Work effectively in a climate of ambiguity and changing priorities • Deal positively with praise, setbacks and criticism; Incorporate feedback effectively • Exercise flexibility and willingness to be helpful in making necessary compromises to accomplish a common goal • Reflect critically on past experiences in order to inform future progress View failure as an opportunity to learn; understand that creativity and innovation is a long-term, cyclical process of small success and frequent mistakes	(when running out of time) "…so let's go to #3 instead of #5"

Initiative, Self-Direction and Productivity	ISP	• Set goals with tangible and intangible success criteria, even in the face of obstacles and competing pressures • Balance tactical (short-term) and strategic (long-term) goals • Prioritize, plan and manage work to achieve intended results • Monitor, define, prioritize and complete tasks without direct oversight • Multi-task • Manage time and projects effectively • Go beyond basic mastery of skills to explore and expand one's own learning and opportunities to gain expertise	Thinking about what to do
Leadership and Responsibility and Accountability	LRA	• Use interpersonal and problem-solving skills to influence and guide others toward a goal • Leverage strengths of others to accomplish a common goal • Inspire others to reach their very best via example and selflessness • Demonstrate integrity and ethical behavior in using influence and power • Act responsibly with the interests of the larger community in mind • Be accountable for results	

APPENDIX H

NGSS, 21st Century Skills, CCSS Math Practices Cross-referenced

NGSS	P21	CCSS MP
1. Asking questions (for science) and defining problems (for engineering)	• Communication and Collaboration • Critical Thinking and Problem Solving	CCSS.Math.Practice.MP1 Make sense of problems and persevere in solving them. CCSS.Math.Practice.MP2 Reason abstractly and quantitatively.
6. Constructing explanations (for science) and designing solutions (for engineering)	• Communication and Collaboration • Critical Thinking and Problem Solving • Creativity and Innovation • Productivity and Accountability • Leadership and Responsibility	CCSS.Math.Practice.MP1 Make sense of problems and persevere in solving them. CCSS.Math.Practice.MP2 Reason abstractly and quantitatively. CCSS.Math.Practice.MP6 Attend to precision. CCSS.Math.Practice.MP8 Look for and express regularity in repeated reasoning.
7. Engaging in argument from evidence	• Communication and Collaboration • Flexibility and Adaptability • Initiative and Self-Direction • Leadership and Responsibility	CCSS.Math.Practice.MP3 Construct viable arguments and critique the reasoning of others. CCSS.Math.Practice.MP6 Attend to precision.
8. Obtaining, evaluating, and communicating information	• Communication and Collaboration • Initiative and Self-Direction • Leadership and Responsibility	CCSS.Math.Practice.MP3 Construct viable arguments and critique the reasoning of others. CCSS.Math.Practice.MP6 Attend to precision. CCSS.Math.Practice.MP8 Look for and express regularity in repeated reasoning.

APPENDIX I

Orienteering Map

1 — 20 pts	4 — 10 pts	7 — 30 pts	10 — 10 pts	13 — 20 pts
2 — 10 pts	5 — 20 pts	8 — 10 pts	11 — 10 pts	14 — 10 pts
3 — 10 pts	6 — 10 pts	9 — 10 pts	12 — 10 pts	15 — 30 pts

APPENDIX J

Orienteering Score Card

Blacksburg M.S.

Orienteering

Period:

Team Name:

1 2 3 4 5

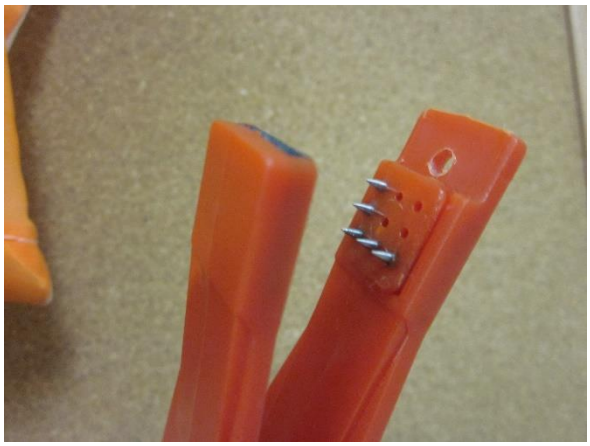
6 7 8 9 10

11 12 13 14 15

APPENDIX K

Control Markers, Punch, and Keychain


SUUNTO



APPENDIX L

Class Visit Lesson

Introduction to Orienteering

I. **Why are we doing this? –** Nature of the research (non-formal learning, P21 skills – problem solving, critical thinking, creativity and innovation, communication and collaboration, flexibility and adaptability, productivity and accountability, and leadership and responsibility).

II. **What are we doing?**

A. Orienteering as a sport (very popular in Europe)

B. Fun problem solving activity involving strategy and teamwork

C. Great for those who like to hike, run cross country or on trails, wander in the woods

D. Video clip- https://youtu.be/LRJgU0I5E

III. **How are we doing it?**

A. Map (ours will be a recent aerial photo of the school and grounds with "control markers" indicated)

B. Discuss and demonstrate how to "orient" a map by turning it the appropriate direction based on landmarks

C. Control markers (show example) – explain points, time constraints and the need for a flexible strategy

D. Teams (pairs) – teacher will use random group generator; two teams in each class will be filmed and interviewed afterwards (explain how GoPro® will work)

E. Appropriate dress – running outside in cold weather – bring hat, gloves, etc.

APPENDIX M

Pre-course Briefing

- Object of the game is to get the most points in the least amount of time
- Time limit is 35 minutes – late penalty is 15 points/minute. It never pays to be late!
- This is a team activity – you must stay with your partner the entire time.
- 15 control markers (CM) – you may find them in any order you choose (show CM example); having a strategy before you start is highly recommended!
- Punch your scorecard in the appropriate box at each CM; leave the CM where you found it! (show punch and pass out scorecards)
- Point values for each CM are listed at the bottom of the map
- Bonus points – "Peaks of Otter" keychain is hanging at one of the "10 point" CMs; the first team to find that CM should take the keychain and bring it back to the finish for an extra 40 points (only 1 keychain is on the course)
- You may cross the road ONLY at the designated "road crossing" (marked on your map)
- Off limit areas = ALL pavement except for designated "road crossing," including parking lots!
- You MAY travel on/through woods, fields, and sidewalks!
- Maps will be distributed once we get outside; finish line is in the same location as the start
- Be safe – watch for cars, mud, and low branches!
- Have fun

APPENDIX N

Orienteering Post-Interview Protocol

Introduction:

You did a great job with the orienteering experience today. I hope you enjoyed it! I'd like to ask you a few questions about your experience. It should only take about 15 minutes. I'm video recording it so we can discuss your answers without taking the extra time to write everything down.

Questions:

1. Did your team begin with a strategy or develop one along the way?
   Probes: What was it?
   Why was it helpful to have a strategy?
   How did the point values of control markers influence your strategy? (including bonus points)
   A. Initiative, Self-Direction, and Productivity (ISP)
   B. Critical thinking (CT)

2. Did your strategy change during the course?
   Probes: What changed? Why?
   A. Flexibility and Adaptability (FA)
   B. Problem Solving (PS)
   C. Initiative, Self-Direction, and Productivity (ISP)

3. Were control markers where you originally thought they were? What did you do when they were not?
   Probes: Why?
   Did this work? Why/why not?
   A. Flexibility and Adaptability (FA)
   B. Critical Thinking (CT)
   C. Problem Solving (PS)

4. Did all team members agree on decisions throughout the experience?
   Probes: What did you do when they did not?
   Did it work? Why/why not?
   A. Collaboration (2)
   B. Leadership, Responsibility, and Accountability (LRA)

5. What do you think were your strengths?
   Probe: Why do you think this was something you were particularly good at?
   A. Leadership, Responsibility, and Accountability (LRA)
   B. Flexibility and Adaptability (FA)

C. Collaboration (2)

6. Which of your strategies or decisions were especially inventive or creative?
   Probe: Did you come up with a way of doing something that was different than what others did?
   A. Creativity and Innovation (CA)

7. What did you learn or figure out as you went?
   A. Flexibility and Adaptability (FA)
   B. Critical Thinking (CT)

8. What would you do differently if you were to do this same course again?
   A. Flexibility and Adaptability (FA)
   B. Leadership, Responsibility, and Accountability (LRA)

9. Tell me the process you used to problem solve when you had difficulties.
   A. Problem Solving (PS)
   B. Critical Thinking (CT)
   C. Creativity and Innovation (CA)
   D. Flexibility and Adaptability (FA)

10. How could this experience help you solve a different kind of problem at home or at school?
    A. Initiative, Self-Direction, and Productivity (ISP)

11. Is there anything else you want to tell me about the experience?

APPENDIX O

Finalized Coding Scheme with Example Utterances

Coding Scheme 1			
CATEGORY	CODE	DEFINITION	Example Utterances
Communication/ Social Skills	1	• Articulate thoughts and ideas effectively using oral, written and nonverbal communication skills in a variety of forms and contexts • Listen effectively to decipher meaning, including knowledge, values, attitudes and intentions • Use communication for a range of purposes (e.g. to inform, instruct, motivate and persuade) • Communicate effectively in diverse environments (including multi-lingual) • Know when it is appropriate to listen and when to speak • Conduct themselves in a respectable, professional manner • Present oneself professionally and with proper etiquette • communicate new ideas to others effectively	Just saying "we" doesn't mean collaboration- it's communication unless there is some back and forth agreement
Collaboration	2	• Be open and responsive to new and diverse perspectives; incorporate group input and feedback into the work • Assume shared responsibility for collaborative work, and value the individual contributions made by each team member • Work effectively in diverse teams • Respect cultural differences and work effectively with people from a range of social and cultural backgrounds • Respond open-mindedly to different ideas and values • Collaborate and cooperate effectively with teams	Question and answer related to the problem "I'll check the trees, you check the door" Exchanging information to come to a decision Talking about ideas

Coding Scheme 2			
CATEGORY	CODE	DEFINITION	Example Utterances
Learning and Innovation Skills			
Creativity and Innovation	CI	• Use a wide range of creation techniques • Demonstrate originality and inventiveness in work and understand the real world limits to adopting new ideas • Create new and worthwhile ideas (both incremental and radical concepts) Act on creative ideas to make a tangible and useful contribution to the field in which the innovation will occur	Out of the ordinary ideas "follow my voice" Making a new idea based on observations
Critical Thinking	CT	• Use various types of reasoning (inductive, deductive, etc.) as appropriate to the situation • Effectively analyze and evaluate evidence, arguments, claims and beliefs and major alternative points of view • Analyze how parts of a whole interact with each other to produce overall outcomes in a complex system (systems thinking) • Synthesize and make connections between information and arguments • Reflect critically on learning experiences and processes	Analyzing what we're doing "…because it's closer" The thinking that informs the plan
Problem Solving	PS	• Interpret information and draw conclusions based on the best analysis • Solve different kinds of non-familiar problems in both conventional and innovative ways • Identify and ask significant questions that clarify various points of view and lead to better solutions	When they actually solve a problem, usually CT first
Life and Career Skills		•	
Flexibility and Adaptability	FA	• Adapt to varied roles, jobs responsibilities, schedules and contexts • Work effectively in a climate of ambiguity and changing priorities • Deal positively with praise, setbacks and criticism; Incorporate feedback effectively • Exercise flexibility and willingness to be helpful in making necessary compromises to accomplish a common goal • Reflect critically on past experiences in order to inform future progress View failure as an opportunity to learn; understand that creativity and innovation is a long-term, cyclical process of small success and frequent mistakes	"(since time is almost up)…so let's go to #3 instead of #5" When they change plan because of something unexpected

Initiative, Self-Direction and Productivity	ISP	• Set goals with tangible and intangible success criteria, even in the face of obstacles and competing pressures • Balance tactical (short-term) and strategic (long-term) goals • Prioritize, plan and manage work to achieve intended results • Monitor, define, prioritize and complete tasks without direct oversight • Multi-task • Manage time and projects effectively • Go beyond basic mastery of skills to explore and expand one's own learning and opportunities to gain expertise	Thinking about what to do A plan Monitoring- "We're running out of time…"
Leadership and Responsibility and Accountability	LRA	• Use interpersonal and problem-solving skills to influence and guide others toward a goal • Leverage strengths of others to accomplish a common goal • Inspire others to reach their very best via example and selflessness • Demonstrate integrity and ethical behavior in using influence and power • Act responsibly with the interests of the larger community in mind • Be accountable for results	Trying to influence Being aware of teammate's needs Taking initiative Compromising Concern for team member

APPENDIX P

Coded Pilot Study Transcript

'1- 10:1	A	(Walking out of the school) Alright, you ready to move this through pretty quick?	2	2	2	2	1 1 1	100%	ISP	ISP	ISP	ISP	1 1 1	100%			goal		
	B	Yeah, as soon as we get our map I have a good strategy.	1	2	2	2	0 1 1	67%	ISP	PS	ISP	PS	0 1 0	33%			plan		
	A	Alright	1	2	2	2	0 1 1	67%				0	1 1 1	100%					
	B	But I don't know beacause I don't know how far out we'll be	1	1	1	1	1 1 1	100%	CT	CT	CT	CT	1 1 1	100%			analyzing potential plan		
	A	Well from what he said they're planted on every single side of the property except the front parking lot.	1	1	1	1	1 1 1	100%	CT	ISP	ISP	CT	1 0 0	33%			the thinking behind the plan		
	B	This parking lot's off limits	1	1	1	1	1 1 1	100%	^	ISP	ISP	ISP	0 1 1	67%			all these are the same idea		
	A	Yeah, except for the front parking lot	1	2	1	1	1 0 1	67%	^	ISP	ISP	ISP	0 1 1	67%					
	B	Nobody's gonna be allowed there	1	1	1	1	1 1 1	100%	^	ISP	ISP	ISP	0 1 1	67%					
	A	Right. And no hopping fences either, so	1	2	1	1	1 0 1	67%	^	ISP	ISP	ISP	0 1 1	67%					
	B	No getting in neighbors either. No getting in any houses. A:/Yeah (laughs) no burglary. Burglary is off limits for this game. B:/It's off limits for everything cause it's illegal	1	1	1	1	1 1 1	100%	^	ISP	ISP	ISP	0 1 1	67%					
	A	Ha, yep. (walking around the school) I'm pretty sure I saw number zero was somewhere on here. Actually.	1	1	1	1	1 1 1	100%	CT	ISP	CT	CT	1 0 1	67%			analyzing map		
	F1	OK, this is our start/finish line right here. Ok, the opening in the fence. Ok so when you come back when you're done you come back to here. Remember if you're planning and want to use the bleachers, we've got bees on this side, we didn't see any bees over here, so you can use the track, you can sit down, you can use the wall, whatever. OK, remember a couple of important things. You're looking where the circles are. This is a map, and a map is like you're flying overhead like a bird. Well I should say this is a little bit, this is an aerial photo. It's not quite exactly a map. The good thing is things are really recognizable like you can see the track and the football field. The bad thing is this was taken when leaves were on the trees and there's shadows. Sometimes it's hard to see what's a shadow and what's a treeline. So kind of keep that in mind. Remember, there's a target circle where that control marker is. It may be even a little bit outside that in some cases. So start there and kind of work your way out. Don't work your way out halfway across the map because that's too far but go a little bit further out from that circle if you think it makes sense. If you start toward the middle, see what makes sense, think about it. Try and think like me, if you were hiding a control marker where would you hide it. A really really important thing too is do not disturb the control markers. All you do is punch. You don't pull on them, you don't untie them, you don't move them.You just take them and "pt" (makes punching motion) and move on.				0	1 1 1					0	1 1 1			(Instructions given by facilitato		
	F2	It's just like a hole punch, like in school				0	1 1 1					0	1 1 1						
	F1	OK, uh, everbody know what they're looking for?				0	1 1 1					0	1 1 1						
stude		yeah				0	1 1 1					0	1 1 1						
	F1	Some are this big (shows with fingers). Some are this big (shows with hands). Nothing is hidden hidden. Sometimes you may have to kinda look behind a tree or underneath the leaves but it's not like look under, turn over rocks or anything like that. Does it make sense?				0	0 0 0					0	1 1 1						
	B	Yep				0	1 1 1					0	1 1 1						
	F1	OK. So as soon as you get a map, which I'm gonna start to pass out				0	1 1 1					0	1 1 1						
	F2	Alright, (passing out maps) so the first thing, you're probably gonna go come up with a strategy				0	1 1 1					0	1 1 1						
	A	Let's see.	1	1	1	1	1 1 1	100%				0	1 1 1						
	F1	Time has started				0	1 1 1					0	1 1 1						
	A	Time has started!	1	1	1	1	1 1 1	100%	ISP	ISP	ISP	ISP	1 1 1	100%			aware of time limitation		
		OK. We are here ok? (pointing on map)		2	1	2	0 1 0	33%	CT			CT	1 0 0	33%	CODE1	CODE2	analyzed current location		
	B	OK A:/Oh, wait, there's one right over there I say we,	2	2	2	2	1 1 1	100%	CT	CT	CT	CT	1 1 1	100%	86%	69%	analysis		
		oh no, wait, let's flip it upside down so say we were right here instead,	2	2	2	2	1 1 1	100%	CT	CT	CT	CT	1 1 1	100%			analysis		
		it would actually be over there (both point). Come on!		2	2	2	0 1 1	67%	PS			PS	1 0 0	33%			drew a conclusion		
		Number 7, I think it was by the treeline right? (running)		2	2	2	0 1 1	67%	CT	CT	CT	CT	1 1 1	100%			analysis		
	B	Yes (running)	1	2	2	2	0 1 1	67%				0	1 1 1	100%					
	A	OK, so remember, there was 45 minutes, 9 markers, therefor we've got about five minutes to get each one.	1	1	2	1	1 1 0	67%	ISP	ISP	ISP	ISP	1 1 1	100%			the plan		
		Since we got off right here, we got a pretty good start. OK		1	2	2	0 0 1	33%	ISP			ISP	1 0 0	33%			evaluation of how the plan is p		
	B	Stop I want to make sure we did it right	2	2	2	2	1 1 1	100%	CT	CT	CT	CT	1 1 1	100%			analysis of past decision		
	A	See where we are.	1	2	2	2	0 1 1	67%	CT	CT	CT	CT	1 1 1	100%					
	B	It's upside down completely	1	1	2	1	1 1 0	67%	CT	PS	CT	CT	1 0 1	67%					
	A	No, that's. I turned it upside down because we were heading the, right there (pointing to the map) so we were here since we were heading that way. We turn it upside down so we can, in a sense, have the right direction B:/ Oh! A:/ Because	2	2	2	2	1 1 1	100%	CI	PS	PS	PS	0 1 1	67%			creative approach?		
	B	Let's look	2	2	2	2	1 1 1	100%	ISP		CT	ISP	1 0 0	33%			MANAGING		
	A	It's kinda, it seemd like an opening in the trees.	1	1	1	1	1 1 1	100%	CT	CT	CT	CT	1 1 1	100%			analysis		
		Remember it'd be this way (pointing) considering we're facing the opposite direction.		2	2	2	0 1 1	67%	PS		PS	PS	1 0 1	67%			evaluation?		
		Oh wait, did we get an orange card?	2	1	1	1	0 1 1	67%	ISP			ISP	1 0 0	33%			remembered the objective		
	B	(looks back) No! Go back	1	2	2	2	0 1 1	67%	ISP	ISP	FA	ISP	1 1 0	67%					
	A	Yeah (starts running). Oh wait, we can't split up.! Oh thank goodness!	2	1	2	2	1 0 1	67%	ISP	LRA	FA	LRA	0 1 0	33%			a requirement?		
	F2	(Handing him score card) You left without a score card.				0	1 1 1					0	1 1 1						
	A	Oh good. (sees other students) Oh, what do you know, I guess that might be it.	1	1	1	1	1 1 1	100%	FA		PS	PS	0 0 1	33%			thinking about changing plan?		
	B	(Seeing crowd) No, let's go and try and find another one and get this one on the way back.	2	1	2	2	1 0 1	67%	ISP	PS	ISP	ISP	1 0 1	67%			one plan		
	A	No let's get it now, we're right here.	2	1	1	1	0 1 1	67%	ISP	LRA	LRA	LRA	0 1 1	67%			a different plan		
	B	No number 2 is over there	1	1	1	1	1 1 1	100%	CT	LRA	LRA	LRA	0 1 1	67%	Code1	Code2	thinking behind doing 1st plan		
	A	Number 2 is over where? Let's see.	2	2	2	2	1 1 1	100%	CT	CT	CT	CT	1 1 1	100%	76%	68%			

	B	(Looking at the map and pointing) Way over there. Number 2 (starts running) Let's go over there,	2	1	2	2	1 0 1	67%		PS	LRA	PS	0	1	0	33%				the plan
		we can get this one on the way back.		1	2	2	0 0 1	33%	ISP		ISP	ISP	1	0	1	67%				
	A	Alright (running) we'll get number 2 and then we'll come back for this one B:/Yep	1	2	2	2	0 1 1	67%	^	LRA	FA	FA	0	0	1	33%				
	A	Like I said, we should have 5 minutes for each one, we have plenty of time.	1	1	1	1	1 1 1	100%	ISP	ISP	ISP	ISP	1	1	1	100%				
	B	May I see the map? (Gets the map) OK, so, we're right here.	1	2	2	2	0 1 1	67%	CT		CT	CT	1	0	1	67%				location
	A	Two should be…right back there (pointing right and continuing to run)		1	1	1	0 1 1	67%	PS		PS	PS	1	0	1	67%				location of 2
	B	You alright Iain? B:/Yep, getting in shape for soccer	2	2	2	2	1 1 1	100%			LRA	LRA	0	0	1	33%				
	A	(Laughs) Alright, (stops running) so we have the opening right here (points).	1	1	2	1	1 1 0	67%	CT	CT	CT	CT	1	1	1	100%				
		I think it might be just behind that tree (points to the map) B:/Alright		1	2	2	0 0 1	33%	PS	PS	PS	PS	1	1	1	100%				
V2- 0	A	Alright (looking at map) The problem is I don't know where the… see the property line's right there. Let's see, so I guess start looking for one of those orange markers (looking) so it's anywhere around these. Just around this treeline (pointing to map.)	1	1	1	1	1 1 1	100%	CT	CT	CT	CT	1	1	1	100%				
	B	Alright. (taking map) A/:So is this		2	2		1 0 0	33%	CT	CT	CT	CT	1	1	1	100%				
	B	It's right on the property line (pointing) It's probably up here.	1	1	1	1	1 1 1	100%	PS	PS	PS	PS	1	1	1	100%				
	A	Yeah, and it's orange and white, right? B/: yep	1	2	2		0 0 0	0%	CT	CT	CT	CT	1	1	1	100%				Putting these two together shows collaboration better AD- (DONE)
	A	Some are small, some are bigger than the others. Ok.	1	1	1	1	1 1 1	100%	CT	CT	CT	CT	1	1	1	100%				
	B	Where is it?	1	1	1	1	1 1 1	100%		PS	CT	CT	0	0	1	33%				
	A	So it can be up here?	1	1	1	1	1 1 1	100%	CT	PS	CT	CT	1	0	1	67%				
	B	It's the op… (pausing) think it's right over here. The map says anyway.	1	1	1	1	1 1 1	100%	PS	CT	CT	CT	0	1	1	67%				
	A	Here, they're all gathered over there, let's see what they found.	1	1	1	1	1 1 1	100%	CI	LRA	CI	CI	1	0	1	67%				
	B	No. That's number 1 (pointing) out on the baseball field.	1	1	1	1	1 1 1	100%	CT	LRA	LRA	CT	1	0	0	33%				
	A	No (pointing) there's a group of people right down there.	1	1	1	1	1 1 1	100%	CI	CT	CI	CI	1	0	1	67%				
	B	Wait a minute, I could've sworn I just saw a flash of orange. Somewhere	1	1	1	1	1 1 1	100%	FA	CT	FA	FA	1	0	1	67%				
	A	Hey Iain. B:/ Yeah A:/(Pointing) Remember you said they could be outside the circle. You have a group of people hiding right there and they're just leaving the area. I say we search it (running that way).	2	1	2	2	1 0 1	67%		CT	CI	CI	0	0	1	33%				Remember, you said…referencing what other person said
	A	There it is, right there B:/Aw!		1	1	1	1		PS	PS	PS	PS	1	1	1	100%				
	A	Great, alright this is number 2 right? B:/Yep A:/ 2 (punches scorecard)	1	2	2	2	0 1 1	67%	CT	CT	CT	CT	1	1	1	100%				Putting these two together shows collaboration better
	B	Aw it's worth some points, awesome!	1		2	1	1 0 0	33%	LRA	LRA	LRA	LRA	1	1	1	100%				
	A	I say we head for 5, or do we go that way?	2	2	2	2	1 1 1	100%	ISP	CT	ISP	ISP	1	0	1	67%				Asking for other person's opinion
	B	(Pointing) Let's go this way for 7.	1	2	2	1	1 0 0	33%	ISP	ISP	ISP	ISP	1	1	1	100%				
	A	Oh, right, 7 not 5. (Running) alright, we know it's right over there (pointing). (Stops running) I'd say we have time, let's look at the map on where we'd be heading next. Alright Iain, can I see the map?	2	1	2	2	1 0 1	67%	ISP	ISP	ISP	ISP	1	1	1	100%				Should we separate this? LM
	B	That's the other thing A:/Right, so remember, 7's over there. (Pointing to map) Number 1, yes, is over by the baseball field. Right over there. And number 6, further up the property line from there. Hmmm. Alright, it was along over there. Number 5, it's on the other side of the property, on the treeline that's heading to the school. After that we have to run all the way around the building . We can stop at 13 and 4 then. Get zero get three and run back	1	2	2	2	0 1 1	67%	ISP	ISP	ISP	ISP	1	1	1	100%				
	B	Which ones are worth double points, which are the ones that are worth double?	2	2	2	2	1 1 1	100%	CT	ISP	CT	CT	1	0	1	67%	Code1	Code2		
	A	Uh which ones are worth double, the ones with the circles?	2	2	2	2	1 1 1	100%	CT	ISP	CT	CT	1	0	1	67%	77%	79%		
	B	6	1	2	1	2	0 1 0	33%	CT	ISP	CT	CT	1	0	1	67%				
	A	6 and 2 are the circled ones	1	2	1	2	0 1 0	33%	CT	ISP	CT	CT	1	0	1	67%				
	B	Yes, we've already punched A:We already got 2	1	2	2	2	0 1 1	67%	CT	ISP	CT	CT	1	0	1	67%				
	B	Oh man! Awww 6 is over by the teamline A:Man! Alright, we'll have to	1	2	1	1	1 0 1	67%	CT	ISP	CT	CT	1	0	1	67%				
	B	We can head down to the baseball field and then we can head there from here	2	1	2	2	1 0 1	67%	ISP	ISP	ISP	ISP	1	1	1	100%				
	A	Yeah, actually I think we head there because then we'd be able to head down to the baseball field from there. Alright, anyway we've got to find this, come on! (Runs)	2	2	2	2	1 1 1	100%	ISP	ISP	ISP	ISP	1	1	1	100%				
		We should've punched it earlier.	1	1	1	1	1 1 1	100%	LRA	LRA	LRA	LRA	1	1	1	100%				
	B	Let me check the map.	1	2	1	1	1 0 1	67%	ISP	CT	ISP	ISP	1	0	1	67%				
	A	Aw, we walked right past it, it's back there	1	2	1	1	1 0 1	67%	PS	ISP	PS	PS	1	0	1	67%				
	B	I'll get it! (running) Punch it real good!	1	2	2	2	0 1 1	67%	FA	ISP	ISP	ISP	0	1	1	67%				
	A	(Laughs) alright (punches card)Number 7, alright.	1	1	1	1	1 1 1	100%	ISP	ISP	ISP	ISP	1	1	1	100%				
	B	Let's head over to the baseball field. Right over here	2	1	2	2	1 0 1	67%	ISP	LRA	ISP	LRA	0	1	0	33%				
	A	Right (running) we probably should've punched 7 the first thing. You good Iain? B:/Yeah	2	2	2	2	1 1 1	100%	LRA	CT	LRA	LRA	1	0	1	67%				
	A	Alright. So what number's over there? By the baseball field? B:/ 1	2	2	2	2	1 1 1	100%	CT	CT	ISP	CT	1	1	0	67%				
	A	1. Ok, (pointing) and then number 6, right over there by the treeline.	1	2	2	2	0 1 1	67%	PS	CT	CT	CT	0	1	1	67%				Anita- Might want to put these together since they are essentially representing the same code DONE

	B	5's over there too. Somewhere. A:/Well B:/Somewhere in there. In that treeline right there.	1	2	2	2	0	1	1	67%	CT	CT	CT	CT	1	1	1	100%		
	A	Alright, I say we head up here first and so then we can just head down and hit to these two. Instead of going here then up and then back down. (Runs) Let's go around the ditch right here. Good.	2	2	2	2	1	1	1	100%	ISP	ISP	ISP	ISP	1	1	1	100%		
		Well I think they're ahead of us. In fact I think they all are. Only got two. Ooh. Which treeline is it?	2	2	2	2	1	1	1	100%	LRA	LRA	LRA	LRA	1	1	1	100%		
	B	6 is over there	1	2	1	2	0	1	0	33%	PS	CT	CT	CT	0	1	1	67%		
	A	Over there? (pointing)	2	2	2	2	1	1	1	100%	CT	CT	CT	CT	1	1	1	100%		
	B	5 is over there	1	2	1	2	0	1	0	33%	PS	CT	CT	CT	0	1	1	67%		ASKING AND ANSWERING
	A	(Pointing) 5 is over there. OK. Let's see the map. Here, can I see the map for a second? It'll free up some space for your hands.	2	2	2	2	1	1	1	100%			LRA	LRA	0	0	1	33%		A-Might want to separate this b/c there seems to be a lot going on in this chunk
		Alright. (looking at map) We've got 6 over there by that first house. It's just gonna be right up here. (Turning map) yeah, telephone's right there, right there (pointing to map) alright.	1	1	1	1	1	1	1	100%	CT	CT	CT	CT	1	1	1	100%		
		Come on Iain you can do it!	2	1	2	2	1	0	1	67%	LRA	LRA	LRA	LRA	1	1	1	100%		
		Let's see. Alright so it'll be right up here along these trees (looking around) Probably behind them.		1	1	1	0	1	1	67%		CT	CT	CT	0	1	1	67%		
		You search these three, I'll search these three. B:/ Alright		1	2	2	0	0	1	33%		ISP	ISP	ISP	0	1	1	67%		A-Could also be CI
6:00	A	Technically we won't be splitting up, we're still in the same area.	1	2	2	2	0	1	1	67%	CI	CT	CI	CI	1	0	1	67%		
		Orange, orange, orange. Man. Come on! Alright. We should've gotten that 7 earlier. It would've saved us the trip back. That cost us right there. Some valuable time.	2	2	2	2	1	1	1	100%	ISP		LRA	ISP	1	0	0	33%		
		Iain did you find anything? Come on, where is it? (turns map) It's gotta be right along here. Hey Iain, come back a little bit this way. Unless you found it. Did you find it?			2	2	0	0	1	33%			LRA	LRA	0	0	1	33%		
	B	No. Oh, here it is. It's a small one. Oh, but this is 5, this is 5. A:/Alright. (Punches card) Oop, puncture it. B:/Here we go	1	2	1	1	1	0	1	67%	CT	PS	PS	PS	0	1	1	67%		
	A	Alright, so wait, we're heading back this way now	1	1	1	1	1	1	1	100%	CT	ISP	CT	CT	1	0	1	67%		
	B	No. That was 5, 6 is over here. Oh, wait no. Wait, what the heck? Is this 6? Or 5?	2	1	2	2	1	0	1	67%	CT	CT	CT	CT	1	1	1	100%		
	A	That's 6. Man, I punched the wrong one. (Punching the other number)	1	1	1	1	1	1	1	100%	CT	ISP	ISP	ISP	0	1	1	67%		
	B	Doesn't matter, doesn't matter	1	2	1	1	1	0	1	67%	ISP	FA	LRA	FA	0	1	0	33%		
	A	It does, I'll have to…I'll repunch this one. Come on	1	2	1	1	1	0	1	67%	ISP	LRA	LRA	LRA	0	1	1	67%		
	B	We have videotaped proof	1	2	1	1	1	0	1	67%	CI	ISP	CI	CI	1	0	1	67%		
	A	Yeah we have proof. Alright, we'll head down that way, we can hit the one on the baseball field and then we have to go around the building. Come on, we're the only ones still over here! (running)	2	2	2	2	1	1	1	100%	ISP	ISP	ISP	ISP	1	1	1	100%		
	B	Yeah they're all over there. So I think we're the only ones going around the building	1	1	1	1	1	1	1	100%	CT	CT	ISP	CT	1	1	0	67%		
	A	Yeah we're the only ones on this side of the building, which means we're behind!	2	1	1	1	0	1	1	67%	CT	CT	CT	CT	1	1	1	100%		
		It's on the..woops, it's on this edge, this round, right here (pointing). Right along here. Alright! Found it! Aw man, last time I went like down this I was hiking on the trail by my house and I fell over and almost broke my ankle. Huh. Wooh. (punching card) Alright, I got 5		1	1	1	0	1	1	67%		PS	PS	PS	0	1	1	67%		
	B	1 is over here, see that bush (unintelligable)	1	1	1	1	1	1	1	100%	CT	ISP	CT	CT	1	0	1	67%		
	A	I'll staple it right next to it.	2	1	1	1	0	1	1	67%	FA	ISP	FA	FA	1	0	1	67%		
		Alright, yeah, let's go to the baseball field. Man, we shoulda got…	2	1	2	2	1	0	1	67%	ISP	ISP	ISP	ISP	1	1	1	100%		
	B	I have an idea where that is. (unintelligable)	1	1	1	1	1	1	1	100%	CT	CI	CT	CT	1	0	1	67%		
	A	Is that it right there? More trees. Alright, so where are we right now. There's that. No it's on that side. It's on that side of the field. Or at least that's what the map says. Still, does that orange thing right there look like anything to you?	2	2	2	2	1	1	1	100%	CT	CT	CT	CT	1	1	1	100%		
	B	Let me check. Gatorade bottle.	1	2	2	2	0	1	1	67%		PS	PS	PS	0	1	1	67%		
	A	Gatorade bottle. Ok. (Looking around field) There's the pitcher's mound, kind of bleacher. Yeah keeping looking around right here (pointing)	1	2	2	2	0	1	1	67%	CT	ISP	CT	CT	1	0	1	67%		
	B	There it is on the trash can! A:/On the trash can? Alright! Woa.	1	2	1	1	1	0	1	67%	PS	ISP	PS	PS	1	0	1	67%		
	B	(Standing behind fence) Pass me the scorecard through the thing so I can punch it.	1	2	2	2	0	1	1	67%	CI	ISP	CI	CI	1	0	1	67%		
	A	We can't go throught the fence. Even if it is a scorecard I don't wanna risk it	1	2	2	2	0	1	1	67%	LRA	LRA	LRA	LRA	1	1	1	100%		
#####	B	Alright. Normally I would, but we're on video here (laughts) Alright what number is this, 1?	2	2	1	2	1	1	0	67%	CT	LRA	LRA	LRA	0	1	1	67%		
	A	1, alright 1 right there (holds it while Iain punches it) Alright, there's 1 B:/Oh God, no. (Drops control marker in trash can) A:/Oh, that's not good	2	2	2	2	1	1	1	100%	CT	LRA	LRA	LRA	0	1	1	67%		
	B	(Takes it out, lays it over edge of trash can) There we go, sorry. That's sneaky. Putting it in the trash A:/Alright B:/I bet somebody moved it	1	1	1	1	1	1	1	100%	CT	CT	LRA	LRA	0	0	1	33%		
	A	We got everything on this side of the route	1	1	1	1	1	1	1	100%	PS	ISP	ISP	PS	1	0	0	33%		INTERPRET INFO AND DRAW
	B	Let me see the map. They're rounding the school so we should go up there (Takes off running)	2	1	2	2	1	0	1	67%	CI	ISP	CI	CI	1	0	1	67%		

	A	Hold on, here look at the map, we gotta go, if we go for 4, we can get 4, 0, 3, come back and get 13.	2	1	2	2	1 0 1	67%	ISP	ISP	ISP	ISP	1	1	1	100%			
	B	Alright, so where are we going first?	2	2	2	2	1 1 1	100%	ISP	CT	ISP	ISP	1	0	1	67%			
	A	Alright, we've gotta head all the way around the school right now.	2	1	1	1	0 1 1	67%	ISP	ISP	ISP	ISP	1	1	1	100%			
		Front parking lot's off limits. I don't know if they would count the sidewalk. Alright, come on. (running) Have we got time?	2		2	2	1 0 1	67%	ISP		ISP	ISP	1	0	1	67%			
	F1	You've got 30 minutes				0	1 1 1					0	1	1	1				
12:00	A	30 minutes, alright (looks at scorecard) 1, 2, 3, 4, alright, we're ahead of schedule.	1	2	1	1	1 0 1	67%	ISP	ISP	ISP	ISP	1	1	1	100%			
		Come on! Let's head behind him. Sorry sir! (runs around man weed eating). Alright. (walks and looks at map) Actually, alright, we can go for 13 here (pointing to map) which is right around here. Get 0, 3, come back for 4 and then a final sprint back. (Talking to himself) Just ignore it, ignore the pain. Alright. 13 is around here.			2	2	0 0 1	33%			LRA	LRA	0	0	1	33%			
	B	I think I see it. Over here! (Running)	1	1	1	1	1 1 1	100%	CT	CT	CT	CT	1	1	1	100%			
	A	Good eye, good eye!	1	2	2	2	0 1 1	67%	LRA	LRA	LRA	LRA	1	1	1	100%			
	B	No! It's an orange cone! A: Aww, come on! Curse you triangle thingama whatsit!	1	1	1	1	1 1 1	100%	CT	FA	CT	CT	1	0	1	67%			
	B	I think it's a square.	1	1	1	1	1 1 1	100%	CT	CT	CT	CT	1	1	1	100%			
	A	It's a square? It says it's right around here. B:/Yep	1	1	1	1	1 1 1	100%	CT	CT	CT	CT	1	1	1	100%	CODE 1	CODE 2	
	A	Can we… anywhere around this lunch area.	1	1	1	1	1 1 1	100%	CT	CT	CT	CT	1	1	1	100%	77%	76%	
	B	Hey you don't think they'd be sneaky enough put it right next to the 13 numbered door	2	1	2	2	1 0 1	67%	CI	CT	CI	CI	1	0	1	67%			
	A	Alright, they wouldn't do that. Let's head around back. Or do you want to check the door? B:/(unintelligable)	2	1	2	2	1 0 1	67%	CI	ISP	ISP	ISP	0	1	1	67%			
	A	Alright, I'll check the trees. We're still in the same area. (hears yelling) Did you find it? B:/No (unintelligable) Oh man (unintelligable)	1	1	2	2	0 0 1	33%	CT	ISP	ISP	ISP	0	1	1	67%			
	A	Oh! Found it, found it!	2	1	2	2	1 0 1	67%	PS	LRA	CI	PS	1	0	0	33%			
		Follow my voice. It's right here in the trees B/: Follow your voice?	^	^	^	^	1 1 1		PS	LRA	CI	CI	0	0	1	33%			
	A	It's right here in the trees	1	1	1	1	1 1 1	100%	PS	PS	PS	PS	1	1	1	100%			
	B	Oh sneaky it's behind the bush. A/: Alright (punching card)	1	1	1	1	1 1 1	100%	CT	PS	CT	CT	1	0	1	67%			
	B	Where are we going next?	2	2	2	2	1 1 1	100%	ISP	ISP	ISP	ISP	1	1	1	100%			
	A	We head around the building to 0 and then to 3 and then the final sprint to 4 and back before anyone else. Let's go! (runs) Because everyone else I think has already been around.	2	1	2	1	0 1 0	33%	ISP	ISP	ISP	ISP	1	1	1	100%			
	B	No, I saw a team heading around. There was one team at 5	1	1	1	1	1 1 1	100%	CT	ISP	CT	CT	1	0	1	67%			
	A	Alright (pointing at map) 0 is, alright, 4 is actually right there,	2	1	1	1	0 1 1	67%	ISP	CT	ISP	CT	0	1	0	33%			
		but we need to get that when we come back. That way we're not… going too far	^	^	^	^	1 1 1		ISP	CT	ISP	ISP	1	0	1	67%			
	B	Yeah, then we can have a downhill sprint	2	2	2	2	1 1 1	100%	ISP	ISP	ISP	ISP	1	1	1	100%			
	A	Alright, number 0's gonna be between the treeline	1	1	1	1	1 1 1	100%	PS	CT	CT	CT	0	1	1	67%			
	B	Right here?	2	2	2	2	1 1 1	100%	CT	CT	CT	CT	1	1	1	100%			
	A	Yeah I guess…so? Man!	2	2	2	2	1 1 1	100%	CT	CT	CT	CT	1	1	1	100%			
	B	This stupid fence. And it's locked too so I guess we're not supposed to go there	1	1	1	1	1 1 1	100%	CT	PS	CT	CT	1	0	1	67%			
15:00	A	It's right, it's right, according to the map, look around, maybe like a tree or something. Other than that, it's right there on the other side of the fence. We'll go back to… B/:I had a feeling they were going to do something like that A:/Uhhh B/: Be right around the fence where we can see it. Tease us. A:/Man B:/ Look at them!	1	1	1	1	1 1 1	100%	CT	CT	CT	CT	1	1	1	100%			
	A	Alright lain it is over there and not on this side. Let's get 4 and we'll head back around.	2	2	2	2	1 1 1	100%	FA	ISP	FA	FA	1	0	1	67%			
	B	Yeah, we can go to 0	2	2	2	2	1 1 1	100%	ISP	ISP	ISP	ISP	1	1	1	100%			
	A	We'll head to 3 and then to 0	2	2	2	2	1 1 1	100%	ISP	ISP	ISP	ISP	1	1	1	100%			
	B	and back	1	2	2	2	0 1 1	67%	ISP	ISP	ISP	ISP	1	1	1	100%			
	A	and then back around.	1	2	2	2	0 1 1	67%	ISP	ISP	ISP	ISP	1	1	1	100%			
	B	You know at first, I though 13 and 0 were inside the building. There it is, right there.	1	1	1	1	1 1 1	100%	PS	CT	PS	PS	1	0	1	67%			
	B	Punch it. I'll start to go around	1	2	2	1	1 0 0	33%	LRA	ISP	ISP	LRA	1	0	0	33%			
	A	Ah, of course it's right in a pine tree (punches card)	2	1	2	1	0 1 0	33%	CT	PS	PS	PS	0	1	1	67%			
		Alright, 3 and 0 that's all we gotta get. Come on! (Runs)	1	1	1	1	1 1 1	100%	CT	PS	ISP	ISP	0	0	1	33%			
		We can't head in the building and we can't go in the parking lot. The building is the solid thing so that means the sidewalk must be on limits	1	1	1	1	1 1 1	100%	CT	CT	CT	CT	1	1	1	100%			
	B	Head down the hill. (unintelligable) A:/Yeah. Hurry they're behind us! It's open, come on! Were you saying something or was that the other team? B:/What? A:/ Did you say anything? B:/No A:/ Ok that was the other team. B:/ (unintelligable)	1	1	1	1	1 1 1	100%	ISP	ISP	ISP	ISP	1	1	1	100%			
	A	Oh my legs feel like I'm gonna fall off. He said the side parking lot right here?	2	1	2	1	0 1 0	33%	CT	CT	CT	CT	1	1	1	100%			GRIT
	B	Let's walk to the sidewalk	1	1	1	1	1 1 1	100%	FA	LRA	LRA	LRA	0	1	1	67%			Making a decision best for
	A	He said the side parking lot right here is on limits, therefor we must be allowed to hit the sidewalk. We just won't be able to touch the pavement.	1	1	1	1	1 1 1	100%	CT	PS	CT	CT	1	0	1	67%			
	B	From here on.	1	1	1	1	1 1 1	100%	CT	PS	CT	CT	1	0	1	67%			
	A	Yep, from here on. We can't touch any of the pavement past that fire hydrant.	1	1	1	1	1 1 1	100%	PS	PS	PS	PS	1	1	1	100%			
		Alright, number 3, number 3 is over there, we'll pass number 3 on the first turn	^	2	^	^	1 0 1		^	ISP	ISP	ISP	0	1	1	67%			

	B	We'll hit 3 on the way back	2	1	2	1	0 1 0	33%	ISP	ISP	ISP	ISP	1	1	1	100%					
V3	A	3 is on the way, 3' s on the way. We've got 3 and then 0.	2	1	2	1	0 1 0	33%	ISP	ISP	LRA	ISP	1	1	0	67%					
		Alright, you ready? Got a second sprint coming? B:/ No	2	1	2	2	1 0 1	67%	ISP	ISP	LRA	LRA	0	0	1	33%					
	A	Alright then	1	2	2	2	0 1 1	67%	^	LRA	LRA	^	1	0	0				GRIT		
	B	But not a long one	1	1	1	1	1 1 1	100%	^	^	ISP	^	1	1	0						
	A	Alright. I hear them behind us. The rules for... B/:Think he's already finished A/:Yeah, probably. I think he yelled done. Anyway B/: We can come in third though cause someone's probably heading back with them A:/Yeah	1	1	1	1	1 1 1	100%	^	ISP	ISP	ISP	0	1	1	67%					
	B	Unless they have no idea how to get back to 0	1	1	1	1	1 1 1	100%	CT	CT	CT	CT	1	1	1	100%					
	A	(Laughs) Let's hope that stumbles others as much as it did us, cause, and hopefully the...oh nope they're coming, let's speed up a little bit. We can just jog a little bit and number 3 will be around this first corner. Let's hope we can find it quick.	2	1	2	1	0 1 0	33%	ISP	ISP	ISP	ISP	1	1	1	100%					
		Alright 3, found it.	2	1	1	1	0 1 1	67%	PS	PS	PS	PS	1	1	1	100%					
		Shhhh, shhh come this way, quiet, quiet.	2	1	2	1	0 1 0	33%	LRA	LRA	LRA	LRA	1	1	1	100%					
	B	But where is 0?	1	1	2	2	0 0 1	33%	CT	CT	CT	CT	1	1	1	100%					
	A	(Whispering) It's this way, by the gate, remember? Quickly! (Turns the corner) See? These guys were finding it too, right? Alright, hello! Alright it's right around here. Can be behind the tree, could be right under the treeline right there.	1	1	1	2	0 0 0	0%	PS	CT	CT	CT	0	1	1	67%					
	B	You look that way, I'll look this way	2	1	2	1	0 1 0	33%	LRA	ISP	LRA	LRA	1	0	1	67%					
	A	Got it (looking at map) alright, 0, 0... (looking around) If anything, I think it'd be on this tree (pointing). That tree right there, or under it, right here. Oh lord, please don't let us missed it on the other side of the fence here.	1	1	1	1	1 1 1	100%	CT	CT	CT	CT	1	1	1	100%					
		Found it!	1	1	1	1	1 1 1	100%	PS	PS	PS	PS	1	1	1	100%					
		Alright, you ready for the sprint back? (punches card)			2	2	0 0 1	33%			LRA	LRA	0	0	1	33%					
	B	Hurry up!	1	1	1	1	1 1 1	100%	ISP	LRA	LRA	ISP	1	0	0	33%					
	A	Was that a whistle? B:/It's a train. A:/Is that what it was? We've got 15 minutes. Come on! Don't touch the pavement	1	1	2	2	0 0 1	33%	ISP	ISP	ISP	ISP	1	1	1	100%					
	B	Hope I don't throw up all over the place. A:/Hey Ethan. Don't worry, we'll sprint once we get to the other side of the building. I wouldn't drink much else or else you stomach will fill up. Save that for the exhausting barf afterwards B:/Oh, yeah, barf. A:/ (Laughs)	2	1	2	2	1 0 1	67%	ISP	LRA	LRA	LRA	0	1	1	67%					
	B	I was running in the Fincastle run and I was drinking a whole load of water A:/Ooooh B/: And I threw up in a trashcan and then collapsed and just sat down A/: Huh, well this is school property so don't throw up anywhere besides the trashcan B:/The Fincastle run for me turned into a Fincastle walk	1	1	1	1	1 1 1	100%	^	FA	^	FA	0	1	0	33%			past experience		
	A	(Laughs) Yeah. Alright, you ready for a sprint back? B:/(starts running)	2	2	2	2	1 1 1	100%	LRA	ISP	LRA	LRA	1	0	1	67%					
	A	Right here on the sidewalk. Alright, push, right past them. You can do it! Cut corners if you have to. We're allowed back on the sidewalk- I mean the pavement. Let's cut through this right here. Come on Iain, we're almost there, we're almost done! Gee this feels like a mile run more then anything else. Hey, right back up there, right back up there! Ah! Fourth place, we just missed it. Fourth? Man! Cross the finish line. Come on Iain, aw right there.	2	2	2	2	1 1 1	100%	LRA	LRA	LRA	LRA	1	1	1	100%					
	F1	34 minutes and 37 seconds! Awesome. You get them all?					1 1 1						1	1	1		CODE 1	CODE 2	40%		
	A	Yep, we got them all, we accidentally got the wrong stamp on a different one. So we restamped 5. Alright!	1	1	1	1	1 1 1	100%	LRA	LRA	LRA	LRA	1	1	1	100%	76%	77%			
								77%					1	1		75%					
																		CI	9		5%
																		CT	66		35%
																		PS	23		12%
																		FA	6		3%
																		ISP	54		29%
																		LRA	29		16%
																		viable nonfrm are characterized by programs that..			
																		COMMUNICATION TO 77			
																		33			
																		COLLABORATION TO 77			
																		31			
																		ALL:	Comm		Collab
																				95	92
																				51%	49%

APPENDIX Q

Pilot Study

Pilot Study

To ensure the research design, data collection, and data analysis procedures were both appropriate and effective for answering the proposed research questions a pilot study was conducted. The following research questions guided the pilot study.

Research Questions

RQ#1: What is the relationship between a non-formal learning experience and acquisition of the following 21st century skills:

1. Learning and Innovation
    - A. Creativity and innovation
    - B. Critical thinking
    - C. Problem solving
2. Life and Career
    - A. Flexibility and adaptability
    - B. Initiative, self-direction and productivity
    - C. Leadership, responsibility and accountability
3. Socio-Cultural
    - A. Communication
    - B. Collaboration

RQ#2: What characterizes a viable non-formal learning experience for student acquisition of 21st century skills?

Methods

Participants

Participants in the pilot study consisted of seven students, ranging in age from 11 to 14, who participated in a STEM summer camp at a suburban middle school in southwest Virginia. These students were divided into dyads (teams of two) while engaged in a 45-minute orienteering experience on the school grounds. One dyad was randomly assigned to wear a GoPro® camera and be video and audio recorded during the experience.

Procedures

The course, consisting of nine control markers of various sizes (Appendix K), was set up the morning of orienteering experience. Control markers of three different sizes (small, medium, and large) were placed based on terrain and visibility. Control markers in open areas were smaller, so they would be more difficult to spot from a distance, while those hung within trees or brush were larger. This placement necessitated student use of the map, rather than merely visual location of control markers. Each control marker was assigned a point value based on difficulty. Five of the control markers were assigned a value of ten points each, two control markers that were more difficult and/or farther from the start/finish were valued at twenty points each, while the two most difficult control markers were valued at thirty points each. Students were tasked with accumulating as many points as possible within a 45-minute time limit. If teams did not return to the starting point within 45 minutes, 5 points were lost for every minute they were late. Points were accumulated by finding a numbered control marker and using the attached hole punch to punch a unique hole pattern into the box on the scorecard with the corresponding number.

Students participated in a brief lesson on reading the map, were given a scorecard, and told rules for the orienteering course. This pre-experience lesson took approximately 20 minutes to complete. Students worked very hard to complete the course as quickly as possible, and all teams arrived back at the starting point prior to the 45-minute time limit. Following the experience, all seven students participated in a post-interview consisting of twelve questions (Appendix D). A stationary camera was set up in a classroom to capture the post-interview. The researcher transcribed the experience and subsequent interview.

Results

The camera captured the dyad's entire orienteering experience, and they naturally articulated their thoughts and experiences throughout. The post-interview was conducted with all seven participants. This occurred after the students waited for everyone to complete the orienteering experience. Students were excited about the orienteering, and they shared their experiences with one another while waiting for teams to finish and while walking back to the classroom. As a result, valuable data relevant to answering the RQs were not captured. Also, while feedback from all students was interesting during the post-interview, it also served to distract discussion away from the phenomena observed within the actual data collection. Recognizing these shortcomings, the research design was modified to conduct the post-interview in the field directly after completion of the experience rather than waiting to walk to a classroom. The pilot study also demonstrated that the post-interview should be conducted with only the video and audio recorded dyads. Not only would this assist in conducting the post-interview directly following the dyads' experience, without waiting for all students to complete the course, it would help focus the discussion directly toward the experiences of those students observed in the video.

Using the preliminary coding scheme based on the Framework for 21st Century Learning developed by Partnership for 21st Century Skills (P21, 2015), student engagement in 21st century skills was evident throughout the transcripts. However, this initial coding scheme proved to have copious overlap between skills and some vague definitions that would cause difficulty in assigning codes, thus leading to low inter-coder reliability. This indicated that both the categorization of 21st century skills and the codes used for those skills needed to be revised. Specifically, the critical 21st century skills, that must be included were divided into three distinct categories: Learning & Innovation (creativity and innovation, critical thinking, and problem solving), Life & Career (flexibility and adaptability, initiative, self-direction and productivity, and leadership, responsibility and accountability), and Socio-Cultural (communication and collaboration). Given these categorical revisions, a newly revised and validated coding scheme was needed to analyze data collected.

Transcription and Coding Process

Transcription. Video recordings of dyad orienteering experiences and post-interviews were transcribed manually with individual utterances from each dyad member entered verbatim into alternating rows of a spreadsheet. Timestamps were inserted every ten minutes to establish reference points throughout each video. This transcription approach resulted in a typed version of the verbalizations between participants and post-interview verbalizations with time-stamps throughout.

Segmentation and coding of text-based verbalizations. The method used to segment the text-based version of dyad verbalizations was conducted utilizing the coding categories previously described. This method involved concurrent analysis of a given transcript by three independent coders. Coders segmented and coded, simultaneously dividing the utterances until

each individual segment contained a single code that reflected only one of the eight 21st century skills. The use of three independent coders ensured rigor and robustness of data analysis.

Arbitration. Once independent coders completed the segmentation and coding of a given transcript, they met to arbitrate. During arbitration, the independent coders compared, discussed, and justified the 21st century codes they assigned to each segment. A final code was assigned where agreement of independently coded segments occurred. Segments that differed in assigned codes required coders to engage in arbitration to dispute the assigned coding and reach agreement on the 21st century skill addressed. Independent coders arbitrated until they reached an agreement on the final code. This coding and arbitration process developed heuristics throughout the coding process of the pilot transcript. It resulted in a final data set that was readied for use in statistical analysis. Frequency counts were extracted from the final arbitrated data by means of Microsoft Excel (2014). Percentage frequency distribution charts were created manually based on these frequency counts. This quantitative data was then compared to qualitative data in the orienteering experience and post-interviews to provide a comprehensive picture for data analysis.

Establishing a Valid Coding Scheme

Collaborating and arbitrating throughout the coding process creates a systematic approach that reinforces clarity and transparency (Hall, et al., 2005). Content analysis through coding and arbitration established heuristics that were utilized throughout the process (see "Example Utterances," Appendix O). Assessment of inter-coder reliability indicates agreement between two or more coders and provides evidence of rigor of analysis (Ryan, 1999; Lu and Schulman, 2008). The measure of inter-coder reliability validates the interpretation of content and quality of research. It requires independent coders to agree on interpretation of the content based on the coding scheme (Cho, 2008). The percent agreement method, which computed the

average pairwise percent agreement (APPA) was used to measure the agreement between coders. To compute this statistic, the average of cases of agreement between coders was calculated by all possible codes in the final protocol. A percentage agreement above 75% was used as a benchmark for coder consensus within the context of the study. This is deemed an acceptable measure in social sciences (Klenke, 2008; Schloss & Smith, 1999; Stemler, 2004).

Developing codes. A preliminary coding scheme (Appendix C) was developed utilizing the Framework for 21st Century Learning Definitions of Learning & Innovation Skills and Life & Career Skills (P21, 2015). After comparing it to the pilot study transcript, it became obvious that this coding scheme contained copious overlap, making it unsuitable for establishing inter-coder reliability. The coding scheme was then paired down, and Communication & Cross-Cultural Skills was separated as a third unique category, rather than combined within Learning & Innovation Skills and Life & Career Skills (Appendix D). After comparing it once again to the pilot study transcripts, this coding scheme was sent to a panel of two individuals selected because of their extensive experience and background in the process of coding and arbitration. The panelists were provided with the *P21 Framework Definitions* (P21, 2015) for Learning & Innovation and Life & Career Skills (Appendix E), and a chart of the P21 skills cross-referenced with *Science and Engineering Practices in the NGSS* and *Common Core Standards for Mathematical Practice* MP1, MP2, MP3, MP6, and MP8 (Appendix H). The original coding scheme (Appendix C), pilot study transcripts (Appendix P), and the coding scheme developed for calibration (Appendix D) were also provided. According to Creswell (2014), the development, implementation, assessment and continuous refinement of the coding scheme is paramount to ensuring quality of analysis of the text. Data were coded using Weber's (1990) eight-step coding protocol (Table 1).

Table 2.

Weber's Eight-Step Coding Protocol (1990)

1. Definition of coding units (e.g., word, phrase, sentence, and paragraph)
2. Definition of coding categories
3. Test of coding on a sample
4. Assessment of the accuracy and reliability of the sample coding
5. Revision of the coding rules
6. Return to step 3 repeatedly until sufficient reliability
7. Coding of all text
8. Assess the achieved reliability or accuracy

The panelists read the original definitions and the pared down coding rubric, indicating whether they agreed or disagreed with each item. If they disagreed, they indicated what needed to be changed (Appendix F). The panelists and lead researcher then met and reviewed all comments, arbitrating solutions for each skill. Through this process, the lead researcher developed a newly revised coding scheme (Appendix G).

Intercoder Reliability Process

Utilizing the newly revised coding scheme (Appendix G), co-coders and the lead researcher individually coded 10% of the pilot study transcript. The student utterances were segmented based on the meaning conveyed (Figure 4)

A	Alright. (looking at map) We've got 6 over there by that first house. It's just gonna be right up here. (Turning map) yeah, telephone's right there, right there (pointing to map) alright.	1	1	1	1	1	1	1	100%	CT	CT	CT	CT	1	1	1	100%
	Come on Iain you can do it!	2	1	2	2	1	0	1	67%	LRA	LRA	LRA	LRA	1	1	1	100%

Figure 4. Segmented transcript example

In the figure above, the utterance of student A is divided into two segments based on meaning. The first segment conveys communication (1) and critical thinking (CT), while the second segment conveys collaboration (2) and leadership, responsibility and accountability (LRA). Individual coders recorded their codes in a Microsoft Excel (2014) document. Arbitration of the

generated codes produced 86% agreement in coding scheme one and 69% agreement in coding scheme two. Based on this arbitration, the researcher and co-coders further refined the coding rubric, then coded and arbitrated another 10% of the pilot transcript, resulting in 76% agreement in coding scheme one and 68% agreement in coding scheme two. This led to further discussion, refinement, and delineation of definitions. The process of coding and arbitrating 10% of the pilot study transcript was then repeated for a third time. The third coding and arbitration resulted in 77% coder agreement for coding scheme one and 79% agreement for coding scheme two. The researcher and co-coders again looked for discrepancies within the coding schemes and worked to further clarify assignments of codes. An additional 30% of the pilot transcript was then coded and arbitrated. This resulted in 77% agreement for coding scheme one and 76% agreement for coding scheme two. The researcher and co-coders once again examined the coding schemes, clarified and further developed heuristics for definitions, and then coded and arbitrated the remaining 40% of the pilot study transcript. Inter-coder agreement of the last 40% was 76% for coding scheme one and 77% for coding scheme two. The inter-coder agreement for the entire pilot study transcript was 77% for coding scheme one and 75% for coding scheme two. This iterative process resulted in operational definitions of codes, heuristics, and example utterances that produced acceptable intercoder agreements (Appendix O).

Pilot Study Resulting Changes

Based on the results of the pilot study, the following changes were made:

- Reorganization of P21 skills into three main categories of skill
- Revised coding scheme based on 21st century skills
- Revised procedures for post-interview
    - Conducted in the field directly after experience
    - Conducted with only participating dyads instead of whole group
- Revised post-interview questions

Instruments and coding scheme resulting from the pilot study were then incorporated into the final research design for the main study. The following sections will provide the details regarding the method used to collect and analyze data in this study.

Appendix R

Initial Post-Experience Interview Notes

Dyad Interview 1

TIME	Sj	UTTERANCE	Notes
1:35	F	Did you begin with a strategy or develop one along the way?	
	A	Well we went to the first one that we felt like it was, and then we went to that one and we went to another one. And after that we decided that we were gonna go around in a circle. First we just went to the two closest ones and then we went around	apply knowledge- build skill, strategic thinking in the field, self-correct, flexibility, learn through experience
	B	The first 3 we decided randomly and then we decided to go in a loop that was semi-close to the where the one we were at was and went around and…	strategy (ct)
	F	Ok, ok, was it real helpful to have a strategy?	
	A	I think it did help because otherwise we would've had to cover a lot more distance. We would've been going over there and then coming back so	self-evaluation, reflection
	B	Yeah I agree	
	F	Did your strategy change during the course of your whole experience? You mentioned that once you decided what that strategy was, did it change at any point in time?	
	A	Not really	
	B	Well we kind of went around in a loop but then, I forgot exactly why we just kind of broke off from that loop	
	A	Because then we had to come across the road	
	B	Yeah	
	A	And then we just	
	B	Yeah	
	F	Ok, were the control markers where you originally thought they were?	
	B	Um, most of them were in about a 5 foot radius of where I thought they would be	

F	So you didn't have any problem finding any of them?	
B	No	
F	Ok, did you all agree on decisions that were made throughout the whole entire thing?	
A	Yeah	
F	Did you pretty much agree or did you have to negotiate some things?	
A	Not really	
B	It was more of a one person, let's do this, the other person, alrighty. Just simple stuff.	cooperation
F	When that happened, was that like, did you each, you know like you made one decision and then you made a decision, or was it pretty much one-sided, or did you both come up with it	
B	Um, I think I did, I think I made a bit more deciding	
A	Yeah he was holding the map	
F	So you had the map	
B	Yeah	
F	Is there anything that you would've done differently?	
A	Not really, other than there was one that we had to come back for in the woods that um, that we, I think, missed, but we would've planned that into our circle. But other than that not really	reflection
B	Yeah other than that	
F	What do you think, while you all were doing this, what do you think your strengths were? What were your strengths that you thought helped you do this?	
A	I think we communicated well, we um	communication
B	Yeah, cooperation	

A	Yeah we didn't disagree on much. And we, when we searched I think maybe one of us would look there, one of us would look in a slightly different direction, so that.	collaboration
B	yeah	
F	So you cooperated well, is that what you're saying?	
A	Yeah	
B	Mhmm	
F	Do you think you had any strategies or decisions that were especially inventive or creative?	
B	Not that I can think of	no CI
A	Not really. We just went to the closest ones	
F	Ok, that was your strategy	
A	Yeah	
B	Mhmm	
F	Did, um, what do you think you might have learned or figured out as you went	
A	I think it's a good exercise for building teamwork skills, and cooperation	collaboration
B	And your respect toward your partner's decisions	collaboration
F	Tell me about maybe the process that you went through whenever you had to solve a problem that you encountered	
A	Well, I mean for the most part things went pretty smoothly, but when we did have a minor problem, just one of us would suggest an idea and we'd think about it for just a few seconds or so and we'd agree on something to fix it. Normally the first idea that was suggested. There wasn't much debate.	problem solving, decision making process, collaboration

	F	How could this experience help you solve a problem, um, a different kind of problem maybe at home or at school? In other words, is there anything that you learned here today, the skills that you learned here today that you might could take with you somewhere else?	
	A	Well as we said a couple times, teamwork and cooperation and even though our strategy was pretty simple, coming up with a strategy I think was important	collaboration, strategic thinking
	F	Ok	
	A	And those are all things that can relate to real life situations	
	B	Yeah	
	F	Anything else?	
	B	(head nod)	
	F	Ok, is there anything else that you might like to tell me about the experience?	
8:00	A	Not really, not anything from me.	

7th period boys (6:30 total)

Dyad Interview 2

TIME	Sj	UTTERANCE	Notes
:52	F	First question, did your team begin with a strategy?	
	A	Kind of	
	B	Kind of	
	A	We decided to find, we had no idea that we were gonna find them all. So what we tried to do is we tried to go, we picked a specific area, like toward the northwest corner of the field	
	B	Over there	
	A	Yeah, the northwest corner of the field, and we picked the, got the highest points out of each area	strategy
	F	Oh, ok. So did your strategy change at any point? Did you have to change it?	
	A	Not really. It worked really well for us. Except I sort of wish we had been a little…we missed one, cause well we overlooked one that we…	
	B	Cause we were, I don't know, I guess we just had our sights set farther, like, but it was actually way closer than we thought it was going to be	continuous self-assessment
	F	So you picked the places that had the highest points	
	B	Well we tried to. Eventually we were just like, there's one!	
	A	Well now we eventually decided to pick, after a while we thought we were running a little bit low on time so we decided to get the ones closest to us, and we decided to work, go far out then work our way back to here.	change in strategy
	F	Were all of the control markers where you originally thought they were? Were they right where you…	
	B	Uh, no	
	A	No. Number 4 was a whole lot farther down than we thought it was.	learning scale
	B	Yeah	
	F	What did you do when you got to somewhere where you thought it should be and it wasn't there?	

B Well I was like Lee, look at the map again

Well we decided, she made me double look, triple check and quadruple check. But then we decided just to keep going because we knew

A we hadn't passed it yet. So

decision-making in the field

Did each of you agree on the decisions throughout the experience? Did you always want to do the same thing or did you ever

F have to...

Well we sort of were, I think we worked good because, you know, whoever sort of came up

A with what we were gonna do first we did so…

collaboration

B Yeah

So there was never a time when you wanted

F to do two different things?

Yeah. Not really. Sometimes he was like "I see it, it's right there" and I was like "what,

B where?" But that's really it.

OK, now that you've done this once, if you had

F it to do again, what would you do differently?

A Ummm

B Probably not anything. I think we did good

A I think we got lucky

B Yeah we did

We got, we were lucky that we had a pretty good idea, cause the map was pretty good, cause it was good that it was aerial it didn't

A just have like a landmark

B Yeah. It was fun, I liked it

Alright, so what do you think, obviously you did really, really well, so what do you think were your strengths? What made you be able

F to do so well?

B Definitely teamwork

A Cooperation

collaboration

B Yeah

Cause there was a couple times that she probably wanted just to leave me in the dust,

A but…

F You stuck together pretty well?

A Except for one part but then I caught up

B He was like "I see it"

A	Well the main thing is that my head set fell off, so I had to pick it up. Well that happened down there and it like got twisted up here	
F	OK, um, let's see, were any of your strategies or any of the decisions you made especially inventive or creative?	
B	I don't know, not really, we kinda just…	
A	Well, we decided, not exactly creative, but not, I don't know	not CI
B	Once we saw groups farther down we were like, hey let's go over there and then we looked at the map and went there. (Looking at another team) Ha! They ran past it too. That's hilarious.	Innovation?
A	They're gonna win, they're gonna win. They got the key	
F	Oh they found the…	
B	Yeah, well one person ran toward the other one	
A	Well yeah, they left each other behind. Cause that's how they outran us, we would've been there first, but	
B	Maybe	
A	No we were there second	
F	So what did you, I just have a few more. What did you learn or figure out as you went?	
A	That the thing, it was, we had to sort of accept and understand that they are there. They're not like mislabeled. Cause it got, sometimes it got a little frustrating cause we'd be like "we're right here"	critical thinking, problem solving
B	It's not here, where is it. Yeah	
A	And sometimes it would look like the circle was on this side and… but it actually was.	
B	Oh yeah, down there, where there's the row of pine trees I was like "I think it's up here" so we ran up and then I saw it like way down there so I like slid down there. That was fun but it was also frustrating because we were like "why is it down there?"	persevere, grit/resilience, safe opportunity for failure

F Yeah, Ok. So when you did have difficulties, when you got to places where you thought they'd be and they weren't there, what did you do to problem solve. Tell me your process, like what did you do next?

A Like sort of let's go a little bit further and see if it's there

B Yeah mostly

A Like sort of problem solve. We would stop, we would look at our map again and just like "hey, maybe we're a little bit this way or we didn't quite get there."

problem solve

F Ok, and then if you went a little further you found it each time, there was no time that it was like…

B Mostly, yeah, um, well this one was really hard but

persevere

A we gave up on number 4 and we came running cause we thought, well we'll get to 5, well we ended up getting to 4 cause 4 was a lot farther down than we thought.

F Ok, and can you tell me any times where maybe this experience, having done this would help you be better at solving problems, like in real life?

A Definitely cause

B Yeah

A In group work, you need teamwork, and I mean the teachers can tell you to work

B Together

A To work together but that's not gonna- they can't make you and when you're

B This is fun so…

A When you're doing something that's fun, but also challenging

collaboration

B You want to work

A Yeah you want to work together and it teaches good teamwork

F Oh, that's a really good way of saying that. Anything else that you want to tell me about? Anything else that might help?

B We should do this more

A We should do this in gym

B Yes!

F Yeah that would be fun

7:48 A But you can be our PE teacher cause you're not yelling at us.

4th period mixed (7:00)

Dyad Interview 3

TIME	Sj	UTTERANCE	Notes
1:23	F	So did your team begin with a strategy or just develop one along the way?	
	A	More of a half strategy	
	B	Um, we kind of did a little bit of each. We had our next move planned and while we were going for that area we would figure out our next move	strategy
	A	Yeah as we were stamping it we would figure out where to go next	
	F	Ok. So what do you think why do you think it might be helpful to have a strategy when you started	
	B	Because you wouldn't be disoriented and confused about where you were going, because there's only…	
	A	We didn't really know where to go constantly so it was really kind of a wager	create anxiety
	B	Cause we thought it was gonna be trouble that there was only a sliver of road that we could go across so if you don't realize that then you could really mess yourself up	
	F	How did the point values of the control markers influence the strategy you had?	
	A	Um, we kind of just ran to whatever was nearest and I said "How much is this worth?"	
	B	We did run the…We didn't really mind the 10 point ones but the 30 point ones we did go for and then the 20 point ones we didn't really…	
	A	Yeah we definitely prioritized the 30 and the 20 and then the 10 if it was near or on the way we just kinda got it	strategy
	B	Mhhm	

F	Ok, did your strategy change during the course, I mean as you started you said you had the strategy whenever you reached the next one, did it change?	
B	Uh slightly	
A	A little bit	
B	Sometimes on the way, you realize that you are not pinpoint where you think you are, so you'd have to	continuous assessment, flexibility
A	Yeah we'd be running and he'd be like...	
B	So if you're running one direction and you thought you were running the other direction to get one then it kinda changes of how you do through out the map	building skill
A	It really changes	
F	Is there anything in particular that changed during that time, you know, your strategy, any particular strategy that changed?	
A	Um, I think I remember running one part to a 30 and he said "Hey there's a 10 nearby" and I said, "Yeah let's just get that one."	
B	Cause there's this huge treeline down there, so	
A	Yeah we kind of had to figure out where to go into and out of, kind of like where people had been	creative, critical thinking
B	Yeah, cause we had to swerve to get to the last, the part that's nearest to the high school	
A	Also we were one of the only people that actually like stayed behind the treeline to get more of them	
B	Yeah because people were walking through it and we figured that would take longer so we went around, and since there were no branches or anything in our way, we could run faster and go through faster	critical thinking- strategy
F	OK, were the control markers where you originally thought they were?	

A Wait, what?

challenge, anxiety

Um, a little bit, I mean, the same thing with the pinpoint thing, it was a little disoriented, uh disorienting, because you couldn't really tell exactly where

B some stuff are

A Yeah

difficulty level

Cause I was looking on the map, and I was thinking if I could find the soccer goal or the football goal then I could find this easier but they weren't on the

B map, so it was a little more difficult

We'd really say it's in this general area and then look for the things blowing in

A the wind or anything like that

OK, did you all always agree on the

F decisions throughout the experience?

A Um, mostly

B Yeah pretty much

F What did you do whenever you didn't?

B Um, we kept on walking to our close…

collaboration

Yeah kinda went to the closest one

A while kinda negotiating

B Where to go

A Which one's better

B Yeah

F Did that work pretty good?

A Yeah it was ok

B Um, yes

Ok, is there anything that you would've

F done differently?

Um, I might have went for, knowing that these are closer than we thought they were. We thought that they were really far apart and we thought that we would only get like four or five of them. Um, so I probably would've actually stayed on the right side to get everything and then went to the left side. Because we kind of did a figure 8

B to get

reflection

A Yeah, we kind of just, also I think we shouldn't have waited in line as long as we did for some of the starting ones

B Yeah

A That took a lot of time

B Cause everybody ran to that one right there and so

A Yeah, they went to that one and then went to that one so it was just kind of

B Yeah

A But then as it went throughout then everybody was spreading out

F So you would've maybe started further in, and then came back

B Yeah

A Like do all those and then do these

F Ok, so what do you think were your strengths whenever you did this, maybe something that you were particularly good at?

A He was very good at figuring out the map, I'm just gonna say that

B I do this kind of stuff a lot, um, it's, hmmm

6:43 A I think we ran a lot

B I think we did run a lot

A Yeah I kind of got tired toward the end

B Yeah

A He just kept running

B And Tanner was like stop, stop, please stop

A Stop

F Which of your strategies or decisions were especially inventive or creative?

A I'm gonna say to stay behind the tree line, because we could've hopped on the bandwagon just kind of gone through and out the trees but we decided it was getting a little scraped up, we were getting a little scraped up so

Creativity & Innovation? Somewhat creative to stay behind the treeline, critical thinking

F And how was that an advantage for you to stay behind?

A	Well we could A, run faster and B, not have to worry about all the branches hitting us	
B	Yeah, it cause it would slow us down so running around the treeline	
A	It was a lot safer too	
B	Yeah	
F	Is there anything…what did you learn or figure out as you went?	
B	What?	
F	What did you learn or figure out as you went?	
B	It's more difficult than it looks	challenge
A	Yeah it's a lot more difficult	
		self-reflection, positive reinforcement
B	Actually it's a little bit easier than it looks because the map can be a little bit confusing but once you get the hang of where the bird's eye view is, like how far apart things are from each other then it gets a lot easier to move to the different points	
A	Yeah. Figuring out where to go	
F	(Interrupted by students) Alright, I'm gonn back up and ask you again, what you learned or figured out as you went	
B	Yeah we figured out the distance between, um…	
A	Yeah as we went we kinda figured out the map a lot better	
		evaluation throughout
B	Because as we were getting to different points we were like it's at this point, but then we realized that it's not around the area we needed to move to the next area, because it was a little bit, um off of where we perceived it to be	
F	Tell me about the process that you used whenever you ran into difficulty. Can you tell me, like what you did	
		decision making in the field
A	Um, we really kept running while negotiating, really	
B	Well, at those points, at some moments we did stop	

A Yeah, sometimes we just kinda stopped and we

B and we looked at the map, we slowed down

A and we looked at the map and said this is here, this is here

B Yeah

A where are we gonna go?

B We slowed down, took our time and then we went for it

F Ok, great. How can this experience help you solve a different kind of problem either at home or here at school. Is there anything, like take-aways from this experience?

B Finding my keys (laughs)

A Really I think it helped a lot with navigating, if you're ever camping or anything, that helped

B Yeah, true

A And also team leadership and working together had a big role to play

collaboration, leadership

B And also learning a new area, so like if you're visiting someone but you've never been to the area, you can figure out better if you have a map nearby

F I want to come back to what you said about finding your keys, tell me a little bit more about that, how do you think that would help?

B Um, this actually kinda taught me to use the landscape to find things. These were orange and white but thos entire area is greyish greenish, mostly green. So if you were even to look very far away, unless it's behind the treeline then you'd even be able to find it from farther away. Like we were around this area here and we looked and we saw number 1

A Yeah we saw number 1 and we just kind of went for it

F	So how does that translate to help you find your keys?	
B	Just uh	
A	They'll be lost forever	
F	Not a test, just a question. You can say pass, it's ok	
B	I don't really know, it was kinda more of a joke than it was actually	
F	Oh, ok I was just wondering	
A	We kind of joked to help us get through this	
F	Is there anything else that you might want to talk about or tell about this experience?	
A	I think it was a lot better than sitting in a classroom listening to someone talking	motivation
B	Yeah, I would really offer this up to people if I could ever find a place to go to to orienteer, because this was really fun and I think a lot of my friends, most of my friends would like to do this because they like to adventure, they like to find things, they love sports and games	
A	It's like recess with hidden learning	motivation
F	I like that, that's good, recess with hidden learning. Good.	
B	Very mysterious	
F	OK, anything else guys	
B	You have anything?	
A	You have anything?	
B	The map could sometimes, like again to the map, it's very confusing because until about halfway through we kind of figured it out and near the end we really understood the map	figuring out
A	I think if we would've had a compass to say like north, south, east and west it would've made it like a whole lot easier	
B	Uh huh	

F When you figured out the map, what are some things that helped you do that? You know, for instance in the beginning you said it was confusing, what things were confusing about it

active learning, figuring out, self-reflection

B So you would think it was in one specific spot and would think you see it or something and you would go to it and you look at your map and you think you know exactly where you are and you realize that the distance is different than what you first thought. So then by trial and error, you could figure out the distance between the two points or whatever

A Not to mention when we were out by the trees, like when we were inside the treeline we couldn't see the school, so we couldn't use the school as a pinpoint location anymore. We really had to improvise from there

F Ok, and then you said about halfway through you started figuring things out

A Yeah

F Is that the distance thing, is that what you figured out?

B Mostly

A Yeah, mostly distance. Distance and kind of like

B The map doesn't really show the landscape, so I mean it shows the area but it doesn't really show the hills, the size of the hills

F Topography

B Yeah

A So we couldn't really tell, well we gotta pace ourselves

self-regulation

B So we could straight shot this forward but then we saw the hill and we had to, uh

A Kinda like jog

B prioritize

making decisions

A Yeah

14:45 F Ok guys, thanks a bunch. Great job

6th period boys (13:15)

Dyad 4 Interview

TIME	Sj	UTTERANCE	Notes
:00	F	Did your team start with a strategy or did you kind of develop one along the way?	
	A	Well first we were like oh there's one right here, so we ran to this one. Oh it's right there. And then we just kind of ran to the closest one.	
	F	OK, so you didn't stop with the map and kind of come up with a …	
	A	Later in the activity	
	B	I was more of the map person, he was more of the one who went to go stamp	different jobs-collab
	F	Ok so tell me about that. You said later in the experience maybe you stopped and came up with more of a plan	
	A	Cause we had most of them, we had a, like, we have time to look where everything was and look on the map	time management
	F	Ok, and you said you were the map person, so did you kind of have a plan, or…	
	B	I just kinda looked at it and as Brett said just went to the closest one and he'd run to there, stamp it and come back out	
	F	So you had kind of a strategy, you each had your job, right? So, did your strategy change at all did you, you know, once you started doing things did you realize anything that made you change what you were…	
	A	Closer to the end, like when she did the 5 minute whistle we kind of picked things up, and like ran the whole way	Change strategies, flexible
	F	Anything else that made you change what you were doing? (head shakes) Pretty smooth. Were all the control markers where you originally thought they were?	

A	There was only, I think there was one, cause I about stepped in the road. Cause I thought it was right there but then we had to cross the road and go, cause they were like right near each other but the road was in the middle, so I thought they were next to each other	Challenge- self direction
F	So other than that did you get to a place where you thought one would be but it wasn't where you thought it would be?	
B	Number 8	
A	Yeah	
F	So what did you do when that happened?	
B	We just followed down the trees until we found it.	
A	We went back in the woods and ran behind it	
B	So people wouldn't see us	Creative strategies?
F	Oh, good idea. Throughout the whole experience, did you guys always agree on what you were doing? Were the any issues teamwise?	
A	I think we agreed	
B	Not really	
F	Not really agreed or not really problems?	
B	We agreed. There wasn't problems	
F	There weren't, so I did notice, I think you'd run ahead and things like that	
A	Yeah	
F	So did you have issues with that Kendall?	
A	Sometimes I ran ahead too much	
F	But it wasn't an issue really? Were you reading the map at the time?	
B	Yep, yeah. Like I'd point, he'd run over there, stamp it and I'd still try to figure out where the map was going	collaboration
F	Ok, so that was part of your plan.	
A	Yes	

F	What could you have done differently? Now that you've done it, if you had it to do all over again knowing what you know now, would you have done anything differently?	
A	I think we would've gone like in a path, so like over here we could've followed…like, cause I remember we were down there (pointing) and we ran straight across and we could've stopped on our way, but	Self-reflection
F	So you saw a better path?	
A	Yeah	
F	Now that you've done it, there's a shorter way, maybe. What do think were your strengths with this? What were you good at?	
A	It was fun.	
F	Yeah, what were some things that were, you know, that made you good at what you did?	
A	Uh, you can answer	
B	He's fast and I can read maps really easily	Leveraging strengths
F	That works. Did you have any strategies or decisions that were especially inventive or creative?	
A	I think once we like, I think to beat another team we like slid down where it wasn't even close and tried to race them. So we like slid down in those trees, we slid down a path and…	Competition spurring motivation
F	Ok, did you learn or figure out anything as you went?	
A	Orienteering is awesome	motivation
F	Ok, and , so when things were not exactly what you thought they were, when they got difficult, can you tell me your problem solving process?	
A	Uh, Kendall	
B	Brett	

	A	Uh, when we had a problem, we kinda looked at the map closer and closer, to see like where this road was like the curve and stuff. So say there's like, I guess all those trees and we'd look at the curve just to know exactly where it was.	Thinking critically, solving problems attention to detail
	F	And, from doing this, could you see how doing this experience can help you solve different kinds of problems either at home or at school? Was there anything that you can think of that by doing this you could get better at?	
	A	She'd get better at reading maps	
	F	Mapreading's a good skill. Anything else?	
	A	Anything else (asking Kendall)	
	B	No	
	F	Anything else you wanna tell me about this experience?	
	A	I hope we can do it again	motivation
5:04	B	Yeah, you guys should come back for just fun	

D. 6th period mixed (5:00)

Dyad 5 Interview

TIME	Sj	UTTERANCE	Notes
:00	F	First question, did your team begin with a strategy or develop one along the way?	
	A	We began with one, so what we thought was to get the furthest one and move in and get the closer ones	Strategy/ct
	F	Ok, how long did you take to plan before you took off?	
	A	It didn't take us that long, it took us 10, 15 seconds just to figure out a plan and then we took off	
	F	And then you were off. You found the road crossing first, right?	
	A	Yeah	
	F	Was it helpful to have a strategy?	
	A	Yeah it was	
	B	(turns hand gesturing "sort of")	
	A	Yeah it was um helpful because if we didn't have a strategy it'd be all mixed up and we wouldn't know where to go and we'd be like, arguing over which one to go to	strategy
	F	Did you guys agree on a strategy?	
	A	Yeah	
	B	We did	
	F	Ok, did the point values on the control markers, did they influence your strategy	
	A	No, we just tried to get them all before the time went up	
	F	And you guys were the ones who found the bonus	
	A	Yeah	
	F	Was that just by accident or were you looking at the 10 point ones first to see if you could…	
	A	Um, we just went to the, we just started going to the further ones and we just found it	
	F	OK, so did your strategy change during the course?	
	A	No	

B Not really, um, we just really, um, one by one we got the closest one, and we just kept, doing that

F Did you find like, did you do like a loop, or how did you…

A Um, we went like this, we went back around and like this (making circle with arm). But we dropped the, I accidentally dropped the keychain so I had to go back to 13, then… perseverance

F Ok, but you found it

A Yeah, we found it

F So which one did you wind up doing first

A We went to number 2 first I think, the one over here

F The on next to the road

A Yeah

F Ok, were control markers where you originally thought they were?

A Um, one of them wasn't, number 15. We searched for it for like a long time. It wasn't long, but we searched for it. Then we decided to move on then we thought that we could probably come back and find it and we did. So it wasn't where we thought it was gonna be, it was further down the trail than we thought Flexible thinking/decision making

B yeah

F At what point did you come back and get it, at the very end?

A No, toward the middle

F Ok, were you nearby

A No, we were all the way down here then we stopped over here, then we just went up

F Did the points on that one, that was a 30 point one, did that influence your decision to go back and look for it?

A Um, we didn't even check the points, we just decided to go get it

B Yeah

F Ok, that was a 30 point one. Cool. Did you guys both agree on your decision making process, like who decided to go back and get…

A	I did because it would be helpful if we got them all. Cause we didn't know if other teams would've like got it or not, so… then we agreed on it	competition
F	Were you good with that or were you like "oh let's keep going"	
B	Um, kind of, I thought it was kind of too late, but	
F	Ok, but you said ok, let's do it	
B	Mmmmhmm	
F	You were like, you're game. Anything else where you maybe had different opinions	
A	No not really	
B	We were just,we were out looking	
F	Ok, go with the flow. Have you guys worked much together in the past on other labs or projects	
B	Not really	
A	Um, no, not really	
F	Ok, did it work, did you feel comfortable	
A	yeah	
F	Of course now looking back you're like "we got them all"	
A	yeah	
F	You did well but, had it turned out differently would you be like "ahhh"	
A	Um, nah I still think it would've been like a fun experience for me and Yungjin	motivation
B	Mmmmhmm	
A	So we would've just had fun	
F	Cool. So what could you have done differently?	
A	Um, not dropped the keychain out of my pocket. To bend over to tie my shoe	
F	Alright, so I noticed your pockets zip, so	
A	Yeah I forgot to zip it	
F	Well that, I'll tell ya, that happens. Anything else?	
A	Um, no, not really	
F	Do you think with the 15 that you abandoned and came back to, any different opinions about that, I mean, would it have been helpful to look longer for it, or were you totally in the wrong spot	

A	We were way up the trail from where it was, so we were in the wrong spot	
F	Ok, you guys did great, so what do you think your strengths were	
A	Working together for one	collaboration
B	right	
A	And like communicating with each other	
F	You talked the whole time?	
B	And our speed	
A	Yea, and our speed. That helped a lot	
F	How much did you run?	
B	We ran a lot	
A	We ran pretty much the whole course	
F	Did you take any walk breaks, or what did you, did you walk to catch your breath?	
B	we took a small walk break and then we tied our shoes	
A	yeah the walk break was after when we came over here and ran completely across the road and stuff	
B	Yeah	
A	Over here from one side of the field to the other, so	
F	How about your route, you think that was pretty efficient?	
A	Um, yeah	
B	Yeah	
F	Your strategy you thought was	
A	Yep	
B	Mmmmhmm	
F	What about your map reading?	
A	Um, our map reading was pretty good except for number 15 which I thought was further up the trail then it was	
B	Yeah, it was up the big field	
F	Ok, did you have any, were any of your strategies or the decisions you made, did you think they were especially inventive or creative? So did you come up with something that was different from what other teams were doing?	No ci?
B	I don't think so	
A	I don't think so, but, no	

F Did you find any markers maybe a different way than you…

A yeah

B yeah

F Remember which ones? (hands them a map)

A Um, hang on (looking at map) wasn't it, pretty sure, it was number 15 again

F OK

A The way we found it

F How'd you finally come into it

A So we went up to number 2, then we came down like halfway in between 2 and 15 and we were like, alright, it should be in here but it turns out it was further down the trail, so then we were like, I think we should explore further down because it might be down in there. Then Yungjin was like yeah I think we should do that. So then we just walked down the trail just a little bit and then we found it

Perseverance, problem solving

F Were you in the trees the whole time or were you on the cross country course

B We were on the cross country

F Ok

A We were on the cross country course

F Yeah, not a lot of markers over there, I'm not sure that I would've…that was different down that way

A Yeah

F Not a lot of fixed course description on the map so that would have, that definitely was different. Um, ok, what did you learn or figure out as you went? What got or became more obvious or easier for you as you went along

B Umm, I'm not sure

F Anything get easier?

A Um, as we went farther along we thought, like we should just, since we checked the time, each time we got one we were like, alright, we can get this one, we can get this one each time, so that's what we did, like help us push on and get our…

Learning from small successes

F So you figured out you could probably get them all

B	Yeah	
F	Now was that your plan originally or were you just gonna get as many as you could	
A	No we planning on getting them all from the very beginning	
B	Yeah	
F	So if you were to do the same course exactly again, anything different?	
A	No, I think we'd keep the same strategy because it worked out fine	reflection
F	Ok, so you had one problem when you couldn't find that one and came back to it, uh, what was the, can you talk about the process that you went through to figure…problem solve that, you know, we were going to get them all, we missed one, so now what	
A	So after we got the ones that, after we got the two that were down here, we cut up the field and we were sitting in the middle of the field talking and we were like, alright, I know we missed number 15, but I think we should go back and try to find that because it might help us out with points, since, uh, more points the better, so that's what we, and we both agreed on it, so	
F	At that point you were still pretty far away from it	
A	Yeah	
B	Yeah	
F	It wasn't right next to you, so basically you made the decision to take the time and go back and grab it	Decision making in the field
A	Yeah	
F	Ok, with that in mind, kinda think about what you did there, you had a problem, you fixed it. How could this experience help you solve a different kind of problem at home or at school? Nothing to do with orienteering or finding something in the woods or the fields. You've just got some issue, with a friend or with parents, or brother, sister...	
A	We can like communicate with each other or work together on some things, then we'd get our relationship goal back up, so	Communication, collaboration

F Ok, anything else

A Um, no

F Uh, is there anything else you wanna tell me about this experience, like it was fun, was it fun?

A Yeah, it was really fun

F Anything else? motivation

A No, not really

B shakes head

F Would you do it again?

A Yeah

B Yeah

A Definitely

F If it wasn't at school would you go out and do it somewhere

A Yeah

8:47 B Totally

E: 4th period boys (8:47)

Appendix S

Student Utterances by Theme

Theme	Student Utterances
Thinking critically to solve problems	1. “when we did have a minor problem, just one of us would suggest an idea and we'd think about it for just a few seconds or so and we'd agree on something to fix it.” (Dyad 1, line 50) 2. “Yeah, the northwest corner of the field, and we picked the, got the highest points out of each area” (Dyad 2, line 7) 3. “Like sort of problem solve. We would stop, we would look at our map again and just like "hey, maybe we're a little bit this way or we didn't quite get there."(Dyad 2, line 60) 4. “…we had to sort of accept and understand that they are there. They're not like mislabeled. Cause it got, sometimes it got a little frustrating cause we'd be like ‘we're right here’” (Dyad 2, line 53) 5. “Yeah we definitely prioritized the 30 and the 20 and then the 10 if it was near or on the way we just kinda got it” (Dyad 3, line 13) 6. “Uh, when we had a problem, we kinda looked at the map closer and closer, to see like where this road was like the curve and stuff. So say there's like, I guess all those trees and we'd look at the curve just to know exactly where it was.” (Dyad 4, p. 4) 7. “Yeah we kind of had to figure out where to go into and out of, kind of like where people had been” (Dyad 3, line 25) 8. “Yeah because people were walking through it and we figured that would take longer so we went around, and since there were no branches or anything in our way, we could run faster and go through faster” (Dyad 3, line 28) 9. “Uh, when we had a problem, we kinda looked at the map closer and closer, to see like where this road was like the curve and stuff. So say there's like, I guess all those trees and we'd look at the curve just to know exactly where it was.” (Dyad 4, line 51) 10. “So we went up to number 2, then we came down like halfway in between 2 and 15 and we were like, alright, it should be in here but it turns out it was further down the trail, so then we were like, I think we should explore further down because it might be down in there. Then Yungjin was like yeah I think we should do that. So then we just walked down the trail just a little bit and then we found it” (Dyad 5, line 105) 11. “It wasn't right next to you, so basically you made the decision to take the time and go back and grab it” (Dyad 5, line 128)

Scaffolded successes encouraging learning/solving problems	1. "The first three we decided randomly and then we decided to go in a loop that was semi-close to where the one was…" (Dyad 1, line 4) 2. "Well now we eventually decided to pick, after a while we thought we were running a little bit low on time so we decided to get the ones closest to us, and we decided to work, go far out then work our way back to here." (Dyad 2, line13) 3. "We had our next move planned and while we were going for that area we would figure out our next move" (Dyad 3, line 4) 4. "to stay behind the tree line, because we could've hopped on the bandwagon just kind of gone through and out the trees but we decided it was getting a little scraped up, we were getting a little scraped up so" (Dyad 3, line 70) 5. "…each time we got one we were like, alright, we can get this one, we can get this one each time, so that's what we did, like help us push on and get our…" (Dyad 5, line 115) 6. "So after we got the ones that, after we got the two that were down here, we cut up the field and we were sitting in the middle of the field talking and we were like, alright, I know we missed number 15, but I think we should go back and try to find that because it might help us out with points since, uh, more points the better, and we both agreed on it so" (Dyad 5, line 3 124) 7. "Um, as we went farther along we thought, like we should just, since we checked the time, each time we got one we were like, alright, we can get this one, we can get this one each time, so that's what we did, like help us push on and get our…" (Dyad 5, line115) 8. "So after we got the ones that, after we got the two that were down here, we cut up the field and we were sitting in the middle of the field talking and we were like, alright, I know we missed number 15, but I think we should go back and try to find that because it might help us out with points since, uh, more points the better, and we both agreed on it so" (Dyad 5, line 124)
Authentic collaboration	1. "It was more of a one person, let's do this, the other person, alrighty. Just simple stuff." (Dyad 1, line 23) 2. "A:/Yeah, cooperation B:/ Yeah we didn't disagree on much. And we, when we searched I think maybe one of us would look there, one of us would look in a slightly different direction, so that." (Dyad 1, lines 33-34)

3. “A:/ I think it's a good exercise for building teamwork skills, and cooperation. B:/ And your respect toward your partner's decisions” (Dyad 1, lines 47-48)
4. “…teamwork and cooperation…” (Dyad 1, line 52)
5. “I think we worked good because, you know, whoever sort of came up with what we were gonna do first we did so…” (Dyad 2, line 22)
6. “A:/Definitely teamwork” B:/Cooperation” Dyad 2, line 34-35)
7. A:/ “In group work, you need teamwork, and I mean the teachers can tell you to work” B:/ “Together” A:/ “To work together but that's not gonna- they can't make you and when you're” B:/ “This is fun so…” A:/ “When you're doing something that's fun, but also challenging” B:/ “You want to work” A:/ “Yeah you want to work together and it teaches good teamwork” (Dyad 2, lines 67-73)
8. “…I’d point, he’d run over there, stamp it and I’d still try to figure out where the map was going.” (Dyad 4, p.2)
9. A:/ “Yeah kinda went to the closest one while kinda negotiating B:/ “Where to go” (Dyad 3, lines 40-41)
10. “Um, we really kept running while negotiating, really” (Dyad 3, line 88)
11. “And also team leadership and working together had a big role to play” (Dyad 3, line 100)
12. “I was more of the map person, he was more of the one who went to go stamp” (Dayad 4, line 6)
13. “Like I'd point, he'd run over there, stamp it and I'd still try to figure out where the map was going” (Dyad 4, line 32)
14. “He's fast and I can read maps really easily” (Dyad 4, line 43)
15. (strengths) “Working together for one” (Dyad 5, line 71)
16. “And like communicating with each other” (Dyad 5, line 73)
17. “We can like communicate with each other or work together on some things…” (Dyad 5, line 131)

Motivation

1. A:/ “When you're doing something that's fun, but also challenging” B:/ “You want to work” (Dyad 2, p.4)
2. “It's like recess with hidden learning” (Dyad 3, lines 115)
3. “I think it was a lot better than sitting in a classroom listening to someone talking” (Dyad 3, line 113)
4. “I think once we like, I think to beat another team we like slid down where it wasn't even close and tried to race them. So we like slid down in those trees, we slid down a path and…” (Dyad 4, line 45)
5. “Orienteering is awesome” (Dyad 4, line 47)
6. “I hope we can do it again” (Dyad 4, line 58)

7. “Um, nah I still think it would've been like a fun experience for me and Yungjin” (Dyad 5, line 59)
8. “Yeah, it was really fun” (Dyad 5, line 135)

Self-evaluation, flexibility

1. “I think it did help because otherwise we would've had to cover a lot more distance.” (Dyad 1, line 6)
2. “Not really, other than there was one that we had to come back for in the woods that um, that we, I think, missed, but we would've planned that into our circle.” (Dyad 1, line 30)
3. “Well we decided, she made me double look, triple check and quadruple check. But then we decided just to keep going because we knew we hadn't passed it yet.” (Dyad 2, line 20)
4. “B:/Mostly, yeah, um, well this one was really hard but A:/ we gave up on number 4 and we came running cause we thought, well we'll get to 5, well we ended up getting to 4 cause 4 was a lot farther down than we thought.” (Dyad 2, line 62)
5. “Sometimes on the way, you realize that you are not pinpoint where you think you are, so you'd have to” A:/ “Yeah we'd be running and he'd be like...” B:/ “So if you're running one direction and you thought you were running the other direction to get one then it kinda changes of how you do throughout the map” A:/ “It really changes” (Dyad 3, lines 18-20)
6. “We didn't really know where to go constantly” (Dyad 3, line 4)
7. “I mean, the same thing with the pinpoint thing, it was a little disoriented, uh disorienting, because you couldn't really tell exactly where some stuff are…Cause I was looking on the map, and I was thinking if I could find the soccer goal or the football goal then I could find this easier but they weren't on the map, so it was a little more difficult” (Dyad 3, lines 31-33)
8. B:/ “so I probably would've actually stayed on the right side to get everything and then went to the left side. Because we kind of did a figure 8 to get A:/ “Yeah, we kind of just, also I think we shouldn't have waited in line as long as we did for some of the starting ones” (Dyad 3, lines 48-49)
9. “Because as we were getting to different points we were like it's at this point, but then we realized that it's not around the area we needed to move to the next area, because it was a little bit, um off of where we perceived it to be” (Dyad 3, line 86)
10. “Closer to the end, like when she did the 5 minute whistle we kind of picked things up, and like ran the whole way” (Dyad 4, line 12)

11. “There was only, I think there was one, cause I about stepped in the road. Cause I thought it was right there but then we had to cross the road and go, cause they were like right near each other but the road was in the middle, so I thought they were next to each other” (Dyad 4, line 14)
12. “I think we would've gone like in a path, so like over here we could've followed…like, cause I remember we were down there (pointing) and we ran straight across and we could've stopped on our way, but” (Dyad 4, line 36)
13. “Um, one of them wasn't, number 15. We searched for it for like a long time. It wasn't long, but we searched for it. Then we decided to move on then we thought that we could probably come back and find it and we did. So it wasn't where we thought it was gonna be, it was further down the trail than we thought” (Dyad 5, line 33)

Reflection, intrinsic positive reinforcement building skill/knowledge

1. “…even though our strategy was pretty simple, coming up with a strategy I think was important.” (Dyad 1, line 52)
2. “Cause we were, I don't know, I guess we just had our sights set farther, like, but it was actually way closer than we thought it was going to be” (Dyad 2, line 10)
3. “Actually it's a little bit easier than it looks because the map can be a little bit confusing but once you get the hang of where the bird's eye view is, like how far apart things are from each other then it gets a lot easier to move to the different points” (Dyad 3, line 81)
4. “So you would think it was in one specific spot and would think you see it or something and you would go to it and you look at your map and you think you know exactly where you are and you realize that the distance is different than what you first thought. So then by trial and error, you could figure out the distance between the two points or whatever” (Dyad 3, line 125)
5. “it's very confusing because until about halfway through we kind of figured it out and near the end we really understood the map” (Dyad 3, line 121)
6. “So you would think it was in one specific spot and would think you see it or something and you would go to it and you look at your map and you think you know exactly where you are and you realize that the distance is different than what you first thought. So then by trial and error, you could figure out the distance between the two points or whatever” (Dyad 3, line 125)

Theme	Frequency	Percentage
Thinking critically to solve problems	11	17
Scaffolded successes encouraging learning/solving problems	8	13
Authentic collaboration	17	27
Motivation	8	13
Self-evaluation, flexibility	13	21
Reflection, intrinsic positive reinforcement building skill/knowledge	6	9
Total	63	100