Title

Student Self-Directed, Interest-Driven Digital Learning: An Investigation into the Characteristics and Motivations of Free Agent Learners

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Student Self-Directed, Interest-Driven Digital Learning:
An Investigation into the Characteristics and Motivations of Free Agent Learners

A dissertation submitted in partial satisfaction of the

requirements for the degree Doctor of Education

in

Educational Leadership

by

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2016

The Dissertation of Julie A. Evans is approved, and is acceptable in quality and form for publication on microfilm and electronically:

Chair

University of California, San Diego

California State University San Marcos

2016

DEDICATION

In Spring 2003, I conducted focus groups with middle school and high school students in five of our nation's most challenged urban and rural communities to learn how students were using digital tools to support their learning, both in and out of school. The existing literature on the student perspective was limited to a few case studies, mostly involving students in suburban communities. I felt a strong need to hear from students in less advantageous situations about their digital learning experiences.

I learned three fundamental truths from those student discussions that transformed my professional practice and my world vision. First, similar to the students in the suburban communities, these students were using a wide range of technologies to support self-directed learning outside of school. This was especially poignant given that most of the students I met with did not have Internet access or computers in their homes, but had the resourcefulness and personal drive to seek out places and people who could provide them with technology access on a regular basis. Second, the students felt frustrated and disappointed with the lack of sophistication in how their teachers were using digital tools, content and resources in school to support their learning potential, and their teachers' seeming unwillingness to listen to their ideas about digital learning. Third, the students believed that their future success beyond high school and the limited resources in their community absolutely depended upon closing the digital disconnect gap between their aspirations for digital learning and the deficiencies that they saw in their current learning environments. A 12th grade girl from Rosedale, Mississippi summed up her peers' perspective succinctly when she asked me, "Why is it that our teachers do not realize that when they hold back on using technology in class, they are holding back our future?"

The Speak Up Research Project was born that afternoon in the Mississippi Delta. Since then, almost 4 million K-12 students representing all kinds of communities and schools around the globe have shared their ideas and aspirations for learning with Project Tomorrow and educators and policymakers worldwide. It has been my honor and privilege to facilitate opportunities for students to have a greater voice in education decisions through the Speak Up process. To all of the students who have shared their views on digital learning over the years through the Speak Up project, I dedicate this dissertation, and my continued work to support your voices and share your ideas with educators and policymakers who are leading education reform efforts. Keep speaking up and sharing your ideas about education. Your voices are more important than ever!

I would like to thank the thoughtful and wise faculty at the University of California, San Diego and California State University, San Marcos for their contributions to my continuing education as a leader and researcher. I was blessed with the most wonderful dissertation committee. Thank you, Dr. Jennifer Jeffries, Dr. Chris Halter and Dr. Patricia Stall, for your support, guidance and encouragement. Dr. Stall, I started this journey with you by asking if you thought I would be a good fit for this program. I am so very glad that you enthusiastically said yes!

Throughout all of my years of research on digital learning, my favorite study team has been my own children, Elizabeth, David and Matthew. They have been participants in this digital learning revolution and while they often chided me with “I don’t want to be a research statistic,” it has been the greatest experience to learn alongside with them. Finally, I would like to recognize my greatest cheerleader, my husband, Ron, whose love and support throughout this journey has made this all possible.

EPIGRAPH

"I'm very interested in chemistry and physics and instead of learning the same lesson that has been taught since the 90's, I've been teaching myself by reading papers I find online, watching videos, going on free online textbooks, and having online discussions."

7th grade "Free Agent Learner" from Arizona

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Professional Preparation

1979	Bachelor of Arts, Political Science Brown University
2016	Doctor of Education, Educational Leadership California State University San Marcos University of California San Diego

Appointments

- Project Tomorrow, *Chief Executive Officer*, *Irvine*, *CA*, *1999 – present*
- Education Resource Network, *Vice President of Educational Content & Marketing, Newport Beach CA, 1998-99*
- Pearson Education, *BrightIdeas National Sales Director, Burlington MA, 1994-98*
- Unisys, *various executive management positions, Santa Ana CA, 1981-92*

Selected Recognitions

- Advancing Women in Technology Association: *Outstanding Executive 2015*
- Center for Digital Education: *honored as one of the Top 30 Technologists, Transformers and Trailblazers for 2015*
- CUE: *recognized as the 2015-16 e-Learning Advocate of the Year*
- eSchool News: *selected in April 2008 as one of ten national thought leaders having the greatest impact on education technology in the past decade*
- International Society for Technology in Education: *2012 Making IT Happen*
- Leader to Leader Institute: *selected as one of 6 nonprofit leaders as a 2002-2003 Frances Hesselbein Community Innovation Fellow*

Selected Authored or Co-Authored Publications (2013 to current)

Baker, A., Dede, C., & Evans, J., *The 8 Essentials for Mobile Learning Success in Education*. November 2014

Baker, A., Dede, C., & Evans, J., *Mobile Frontiers in Higher Education.* October 2015

Evans, J., Gohl, E., & Wolf, M., *Moving Along the Right TRAAC: Accelerating Digital Adoption through Peer-Coaching and Collaboration.* March 2016

Evans, J. *A Vision for Mobile Learning More Verbs, Fewer Nouns.* Educational Leadership, May 2015. 72(8), 10-16.

Evans, J. *Students' Self-Directed, Interest-Driven Digital Learning: An Investigation into the Characteristics and Motivations of Free Agent Learners.* June 2016 (pending)

Project Tomorrow. *The Double Bottom Line with Mobile Learning: Closing the Homework Gap and Enhancing Student Achievement.* November 2015

Project Tomorrow. *Digital Learning 24/7: Understanding Technology — Enhanced Learning in the Lives of Today's Students.* April 2015

Project Tomorrow. *The New Digital Learning Playbook, Advancing College & Career Ready Skill Development in K-12 Schools.* June 2014

Project Tomorrow. *The New Digital Learning Playbook: Understanding the Spectrum of Students' Activities and Aspirations.* April 2014

Project Tomorrow. *Learning in the 21st Century: Digital Experiences and Expectations of Tomorrow's Teachers.* September 2013

ABSTRACT OF THE DISSERTATION

Student Self-Directed, Interest-Driven Digital Learning:

An Investigation into the Characteristics and Motivations of Free Agent Learners

by

Julie A. Evans

Doctor of Education in Leadership

University of California, San Diego, 2016
California State University, San Marcos, 2016

Professor Patricia Stall, Chair

For today's student, learning is not limited to the classroom or the afterschool program, but rather happens across a variety of settings and through a seamless flow of practices from morning to night. The increasingly ubiquitous availability and access of new digital tools and resources such as social media, mobile devices, online communities and games is the fuel that is propelling this new learning paradigm. Yet, for the most part, these self-directed, interest-driven digital learning experiences, which are beyond the sponsorship of teachers or other adults in formalized learning environments are often discounted and devalued as trivial by educators. Emerging research on how and why students pursue self-directed, interest-driven digital learning is stimulating new conversations around the imprecision of traditional terms such as informal and formal learning, and how various technologies can engage students in learning, enable the acquisition of workplace ready skills, and empower the development of student identity and capacity to become independent, self-directed learners. Current research on student learning with technology focuses primarily on how students are using digital tools and resources under the direction of teachers or other adults in both formal and informal settings. However, a nascent set of research is emerging that presents a case for how students are using new media tools to self-direct learning around academic interests and personal curiosities about their world. Using existing literature and self-determination theory as a foundation, the study examines this emerging cohort of *free agent learners* through a secondary analysis of a large, national data set that includes both quantitative and qualitative results. Extending the work of leading researchers, the *free agent learner ecosystem* explains how students are self-directing their learning around interest-driven topics, what tools they are using to scaffold these experiences, and the motivations propelling these emerging learning behaviors. The discussion of the motivations results in the emergence of a grounded theory about the centrality of purpose in driving students' free agent learning behaviors. The findings of this study will help educators and policymakers understand the digital learning lives of today's students as input to improving school-based learning experiences for all learners.

CHAPTER ONE: INTRODUCTION

Statement of Problem

Despite the proliferation in the use of various technology tools and resources in our everyday personal lives, many educators and researchers believe that the impact of the use of such technologies to transform teaching and learning in most K-12 schools has been limited. This situation has not been lost on the students who increasingly feel that their schools do not “look like the world in which they live” (Spires, Lee, Turner, & Johnson, 2008, p. 510). The students’ rich and varied out-of-school use of digital tools to support personal networks, communications, information collection, and social interactions stand in stark contrast to how technology is typically used in their classrooms (Spires et al., 2008). Prensky (2008) positions students’ informal digital activities as central to their success in the 21st century global economy and contends that their out-of-school, technology-enabled learning experiences are often more meaningful educationally than what happens during their standard school day. Paradoxically, these informal experiences of students are often discounted or excluded from school conversations about how to effectively leverage emerging technologies within learning environments despite extensive recent research on the familiarity of today’s students with these digital tools (Boyd, 2007; Clark, Logan, Luckin, Mee, & Oliver, 2009: DeGennaro, 2008; Greenhow & Robelia, 2009b; Harlan, Bruce, & Lupton, 2012; Ito, 2010; Prensky, 2008; Spires et al., 2008; Squire & Dikkers, 2012). Additionally, given that the literature supports how the use of technology outside of school supports the development of career ready skills, Wagner’s (2008) assessment that the expectations of the *new world of work* in the 21st century are not being met by what students are learning in the *old world of school* supports the students' perspective as well.

Recent research, however, points to the potential of using emerging technologies such as games, social media tools, and mobile devices to stimulate the creation of different in-school learning environments for students. The majority of the research available focuses on the use of these emerging technologies during the school day or in afterschool and summer programs where the use of the technology is typically sponsored, structured and directed by an adult such as a teacher, informal educator or program director. A nascent set of research is developing, however, that examines how students' self-directed, interest-driven use of digital tools outside of a formalized education setting is influencing their desire to acquire skills and knowledge through digital learning opportunities at school. For the most part, researchers interested in this topic area to date have favored small-scale case studies, observations, and other limited qualitative or descriptive approaches to understanding how students are using digital tools to self-direct learning (Ross, Morrison & Lowther, 2010; Selwyn, 2007). Additionally, the limited studies have focused on the logistics and interpretations of students' use of discrete types of digital media or tools (i.e. digital games, online communities, mobile devices) rather than developing a learning ecology perspective on the interlaced media culture to explain how the technology is supporting students' motivations for learning (Drotner, 2008). The dearth of quantitative data from students on their lived experiences using digital tools beyond adult sponsorship presents an opportunity for new research that balances rigor with applicable relevancy to real world education settings.

Research Questions

My interests within this emerging field of students' interest-driven learning are the result of my professional work for an education nonprofit organization. For the past twelve years, I have led a large scale, national mixed methods research study to explore the role of digital tools and resources within K-12 teaching and learning environments. Our study has effectively documented the increasing access that students have to various technologies both in school and out of school, and their often-frustrated aspirations for using tools such as games, social media tools, and mobile devices as learning devices in school.

One of the most interesting findings from the Speak Up research has been the emergence of what I call the "*free agent learner*," the digitally connected and savvy student who is leveraging online tools and resources to support self-directed, interest-driven digital learning outside of conventional learning environments. The phenomenon was first reported in a 2010 research report I authored after identifying the trend from an analysis of a specific survey question about students' use of technology outside of school for learning purposes (Project Tomorrow, 2010). Though representing a small subgroup of middle and high school students at this time, it was surmised that the *free agent learner* might be a harbinger of a new class of students who have evolving views on learning experiences. As discussed by Pink (2009), people are innately curious and often pursue interests and learning to satisfy that curiosity or to solve a problem. Prior to the ubiquity of Internet access, students needed to have physical access to library resources or experts in a particular field to satisfy those curiosities. However, the accessibility and/or quality of those resources were not always readily available or consistent, thus creating an inherent situation of inequity for educational opportunity. Today, empowered by personal access to the Internet, networked publics and a variety of emerging digital tools, the potential exists for all students and especially for this emerging cohort of *free agent learners* to pursue a highly personalized learning path to address interests and motivations for learning. Technology has long promised to level the playing field in terms of equitable access to educational opportunity. While achieving that promise is still a work in process within many schools, it may be that an increased understanding of how students are self-directing learning beyond the classroom using digital resources can drive new approaches and models for in-school use of technology and support education leaders' innovative efforts to close the intractable achievement and preparation gaps in our education systems.

The primary research question therefore driving this study is to identify the learning behaviors, characteristics and purposes of students who are using digital tools to pursue self-directed, interest-driven learning outside of school. To explore that primary question, this study examined the validity of a working hypothesis on the activities and values of the *free agent learner* derived from the literature and my previous research. The working hypothesis is as follows:

Students are exhibiting the characteristics and behaviors of free agent learners when they use digital tools, resources and content outside of school to self-direct learning around areas of academic passion or personal curiosity, and these activities align with the identifying characteristics of self-determination theory (autonomy, competence and relatedness) and demonstrate a purposeful reason for the self-directed actions.

Given this working hypothesis, the following two secondary research questions are central to driving this study. The intent of these two secondary questions are further explained with the supplemental queries.

RQ1: How are students using digital tools, resources and content outside of school to self-direct learning?

- What tools are these self-directed learners using with regularity?
- Are there relationships between these self-directed behaviors that are significant to understanding this emerging phenomenon?
- Are there significant differences or similarities in these learning behaviors that are predicated on gender, technology skill assessment, home Internet access, student interest in a specific career field, or school community profile?
- How do the self-directed, interest-driven digital learning behaviors support self-determination theory?
- Are there relationships between students' self-directed learning behaviors and their attitudes about learning in general?

RQ2: What purposes are driving the ways students are using digital tools, content and resources outside of school to self-direct learning?

- What are the most common purposes identified by the students?
- Are there significant differences in the purposes stated by students for their self-directed learning activities that are based upon the type of tool used for the self-directed learning or school community profile?

Significance of the Study

Structural, political and cultural tensions often inhibit the adoption of innovations. Such is the case with the lack of appreciation by educators regarding the value of students' self-directed, interest-driven digital learning (Bowers & Berland, 2012; Grant, 2011; Greenhow & Robelia, 2009a; Ito, 2010; Lai, Khaddage, & Knezek, 2013). Many teachers continue to see online and video game playing by students as a passive and frivolous waste of time without any potential to impact achievement or skill development despite research that supports increased student outcomes with education games (Bowers & Berland; Grant). Lai, Khaddage and Knezek postulate that teachers do not value or understand how digitally facilitated informal learning can complement the formal, standards-based instruction that is happening in their classrooms. Part of that problem may be teachers' lack of knowledge about how to use technology within learning. Greenhow and Robelia and Ito however believe that the roots of this disconnect between students and teachers on interest-driven learning goes beyond the conventional wisdom of Prensky's (2008) digital natives versus digital immigrants debate.

Rather, new theories about what constitutes knowledge in the 21st century and how that knowledge is acquired are part of this mounting tension between adult authority and student autonomy. Drotner (2008) notes that while classroom learning continues to be focused on conceptual knowledge attainment, students' self-directed learning places a higher emphasis on problem solving and pursuing random academic curiosities. The chaotic nature of the learning experience in personal usage, what Drotner calls an example of "collage creativity," is inherently non-linear and thus an alien concept to most teaching practices (pg. 172). As students increasingly have ubiquitous access to information in the palm of their hands and begin to identify with their new roles as content creators, particularly when their own interests drive that content, the formal education community may be losing its grip on the knowledge monopoly (Ito, 2010).

Evidence of students' interest-driven digital learning, such as identified through this study, validates the need for education leaders to think beyond traditional learning settings and to appreciate the ways that students are self-directing meaningful learning experiences without the sponsorship of teachers and other adults. Beyond the classroom and school building walls, students are developing their own learning ecosystems that highly value collaboration, knowledge sharing and peer mentoring (Barron, 2006; Ito, 2010). Their interest-driven participation with digital tools results in personal identification as learners and experts, and the development of the workplace ready skills that are the reportedly desired outcomes from the Common Core State Standards. Yet, while the research is still embryonic on many aspects of students' self-directed, interest-driven digital learning, it is already evident that digital tools used both in school and out of school have significant potential to disrupt and transform our belief systems and assumptions around student learning.

However, the full-scale realization of these potentially disruptive beliefs depends upon how effectively school and district leaders approach the use of technology within instruction. Reinhart, Thomas and Torskie (2011) provide evidence that the primitive use of digital tools by teachers in our high need schools is enabling a new type of digital divide that cannot be ignored. DeGennaro (2008) notes that effective adoption and adaption of technology tools within instruction may depend upon the establishment of a new culture within the school where it is accepted that the teacher and the student are colearners in the design and implementation of emerging technologies to support learning. Drexler (2010) expands that view and postulates that a co-learning culture depends upon the teacher acknowledging that they “may not be the only expert in the learning process” (p. 374). This same premise may apply to our school and district leaders as well.

From a strengths-based perspective, it is imperative that today’s education leaders tap into the rich experiences that students are having outside of school with technology to support the transformation of the classroom experience. Students’ use of emerging technologies such as games, social media and mobile devices to pursue self-directed, interest-driven learning outside of school provide a treasure trove of competencies and information that can be better leveraged to both increase student engagement in learning, as well as to support student and teacher skill development. Trespalacios, Chamberlain, and Gallagher (2011) state that a significant leadership challenge, therefore, may be for educators to develop the will to both envision the future and to create new learning environments that position students for success in the globally information-intensive economy and society. The significance of this study therefore is to provide education leaders and policymakers with a new understanding about the 24/7 digital learning experiences of today’s students. With that knowledge, our leaders will have the tools to support new school cultures and the types of learning experiences that all students need to fulfill their potential to become our world’s future leaders, innovators and engaged global citizens.

Methods Overview

The study undertaken was a secondary analysis of a large-scale data set with a goal to test the working hypothesis about the *free agent learner* using quantitative and qualitative data collected from middle school and junior high students. The data set utilized was the Speak Up Project data collected via an online questionnaire October 6, 2014 through December 19, 2014. After data cleaning and removal of missing data, the sampling is 133,212 cases. The analysis design was two-phased. In Phase I, the aggregated data collected nationwide was analyzed to answer the research questions that identified the self-directed learning behaviors of the free agent learner. This was accomplished using a variety of descriptive analytical processes. In Phase II, qualitative data originating from an open-ended question on the survey was analyzed to identify the purposes behind the self-directed, digital learning behaviors. Data from six specific middle schools representing a diverse set of communities and student demographics was selected for a summative content analysis.

Organization of the Study Findings

The organization of the study findings serves two purposes. The first purpose is to present the case for the study both in terms of the need for the research and the foundational basis for the methodological process of the study. The second purpose is to guide the ongoing work of the researcher by providing a written testimony to the efforts undertaken to date, and to remind the researcher as to the significance of the implications of the findings. Both of these purposes share equal merit.

In the first chapter, the introduction, I provide an overview of the problem that is driving the study and the derivative research questions. The first chapter also includes an introduction to the significance of the study especially as it relates to leadership implications for school and district leaders. A brief synopsis of the methodology for the study is included.

The second chapter focuses on what I have learned from the literature about the study topic. The literature review contains three primary sections. To establish the foundation for the literature on student technology usage, I first introduce self-determination theory as a theoretical framework to scaffold the data analysis and the findings. Next, I include representative research on how students are using technology to support learning in three settings; at school, in afterschool or summer programs, and at home. Finally, a review of the emergent literature around students' self-directed digital learning experiences highlights the paucity of quantitative, large-scale research on this topic. The literature provides the foundation for the identification of the research questions as well as the determination of the most appropriate study methodology.

The third chapter describes the methodologies undertaken in the study and begins with an overview of the research design. As the study is a secondary analysis of a large-scale quantitative data set, the emphasis in this section is on the sampling and population included in the data set and the analytics used to address the research questions. The connections between the research questions, the theoretical frameworks and scaffolding and the analytical methodologies employed are explicitly detailed in this chapter.

In the fourth chapter, I discuss the findings from the analysis of both the quantitative and qualitative data selected for this study. The discussion in this chapter is explicitly written to provide value to the primary audience for this study, education leaders in K-12 schools and districts.

The final chapter, the summary and conclusions, includes important implications and significance of the study for educational leadership, social justice and additional research. Within this chapter, I advance a grounded theory to explain the purposes of the self-directed, interest-driven digital learning behaviors. The Appendices include copies of the 2014 Speak Up survey instrument for students in Grades 6-8, the Project Tomorrow permission form to use the data set and the descriptive statistics from the study results.

CHAPTER TWO: REVIEW OF LITERATURE

The purpose of the literature review is to establish a foundation for the research undertaken in this study. Given the research questions, a solid foundation of literature across three specific literature fields is required. First, at the heart of student self-directed, interest-driven digital learning is a desire by students to have greater control over their learning processes. The theoretical framework of self-determination theory (SDT) establishes a context for understanding student motivation and the importance of motivation and engagement in the learning process. Using that framework as the starting point, a review of the recent literature on the use of technology by students documents the impact of digital tools in three distinct learning environments: at school, in afterschool or summer programs, and at home. The value of the technology usage across all three settings is demonstrated by an increase in student engagement in the learning process, the acquisition of 21st century workplace-ready skills and literacies, and the development of student identity and capacity to become independent, self-directed learners.

A common thread throughout the literature is a new understanding of the potential value of tapping into students' out-of-school experiences with technology to instigate transformational change within traditional K-12 education. The third part of the literature review therefore examines recent studies on the impact of digital learning experiences where the student is the driver of that experience, rather than a teacher or another adult. The value of those experiences focus on enhancing a student's self-efficacy as a learner and the development of highly contextualized 21st century workplace ready-skills and literacies. Though a new field of research, the goal of translating students' personal experiences into new classroom practice has significant implications for school and district leadership and their abilities to address emerging social justice issues inherent in both school and home technology access. Wagner (2008) however extends the social justice argument beyond simple digital connectivity. As he explains, even our nation's best schools continue to focus on old world school tasks and paradigms that do not address the development of the types of skills that students will need to thrive and compete in the global information economy and society. Thus, the *Global Achievement Gap*, as Wagner terms it, is increasingly less about resource disparity in our schools, and more about a mismatch between what students are learning and what they will need for post-school success. The increasing importance of this issue transcends community type and family socio-economic indicators.

The literature review circles back to the practical application of SDT as a theoretical framework with some recent studies that examine digital learning impacts through that specific theoretical lens. The work of Pink (2009) and Wagner (2008, 2012) have strong resonance as they reposition elements of SDT within the specific context of motivation, student learning and preparation for post-school success. Discussions around the relationships between motivation, student learning and preparation for post-school success are of high interest amongst education and policy leaders as the implementations of Common Core State Standards and other new state standards that put an emphasis on college and career readiness mature and evolve.

The current body of research provides new insights into the value and efficacy of using technology in school to support student engagement and skill development, and the potential of students' out of school experiences to prepare them for post-school success. However, additional research is needed to understand how and why some students are using these tools to self-direct learning beyond teacher sponsorship, and student perceptions on the value of traditional school experiences within the context of their self-directed, interest-driven digital learning lives outside of school.

The Theoretical Framework of Self Determination Theory

Ryan and Deci's self-determination theory (SDT) provides a potential foundation for understanding how intrinsic motivation supports students' self-directed, informal learning. At its heart, SDT postulates that intrinsic goals are directly linked to the satisfaction of three basic psychological needs; autonomy, competence and relatedness (Ryan & Deci, 2000; Vansteenkiste, Lens, Deci (2006). While not ostensibly designed to explain educational outcomes, many researchers have adapted SDT to support theories and discussions around the relationship between academic achievement, motivation, engagement and different types of learning environments including informal spaces (Boekaerts & Minnaert, 1999; Martin & Dowson, 2009; Toshalis & Nakkula, 2012).

The studies identified have special applicability to the topic of student self-directed learning. As Boekaerts and Minnaert (1999) point out, in most school environments, the learning process for students is in service to teacher goals, not student self-initiated motivations. The *autonomy* component of SDT relies heavily upon students having a choice in how, when and where they learn. While the researchers identified that many students set different goals for themselves in informal settings compared to the traditional, formal school environment, more research is still needed to understand what types of different environments are best for individualized students, and which environments inherently support SDT and the development of intrinsic motivations.

In their research, Martin and Dowson (2009) focus on the recognition of relatedness, another foundation block of SDT, as a fundamental ingredient of student motivation in learning content. They postulate that when students feel a connection or sense of *relatedness* to peers and teachers, they are more likely to take on tougher academic challenges, set positive goals for their achievement and establish high expectations for themselves, thus extending the learning beyond the initial goals.

Toshalis and Nakkula (2012) build upon the findings of their colleagues and introduce self-regulation theory into the discussion by examining how students sustain their engagement in learning beyond those initial goals. For this research team, a student's ability to identify and implement specific strategies that support their academic learning process is the key to successful self-regulation. With an explicit recognition that students are the primary agents of their own learning, they surmise that self-regulation (the ability to sustain the motivation and engagement) is best served when students feel a sense of *competency* (another building block of SDT) in a specific domain, field or study or task endeavor.

SDT provides a plausible starting point for understanding the benefits of motivating students with intrinsic goals rather than extrinsic goals. However, it can also be applied to explore the role of technology in supporting students' intrinsic goals for academic success. The potential for digital tools and resources to support students' abilities to self-direct their own learning based upon personal interest choices (*autonomy*), to enable social learning environments that support connections and relationships (*relatedness*), and to establish personalized strategies that drive self-efficacy and agency as a learner (*competence*) are important considerations for education leaders today.

Adult Sponsored Student Use of Emerging Technologies for Learning

The existing literature about the impact of digital tools and resources on student learning focuses predominantly on how students are using technology under the direction of teachers or other adults in both formal and informal learning settings. The technologies studied include educational games, mobile devices, social media resources and digital content development tools. Researchers have identified three primary impacts of student use of such digital tools in adult-sponsored educational settings. First, the studies identify certain parameters or conditions that must be in place for the inclusion of technology within a learning activity to result in increased student engagement in content or process. Understanding the increasing importance of students' acquisition of workplace ready skills, research also points to a connection between the use of technology and students' development of college and career ready skills such as collaboration, critical thinking, creativity and communications. This focus on students' preparation for future success through academic proficiencies alongside practical skills development is a tenet of many district implementations of the Common Core State Standards. Finally, students' use of digital tools and resources in authentic learning environments provides unique opportunities for students to build personal skills and capacities that support self-directed learning. This body of literature provides a solid foundation for understanding the evolution of research in this field from adult-sponsored activities to student self-directed, interest-driven learning.

Using technology to engage students in learning. A common perception held by many teachers and administrators is that the mere presence of technology within instruction promotes greater student engagement in learning. Several recent empirical studies support the relationship between student engagement and the use of technology in school, and in afterschool and summer program settings. However, these studies also identify other factors that influence and inform this linkage between engagement and technology. The research advances the idea that student engagement using technology is predicated on the existence of three conditions: 1) the authentic inclusion of students' ideas and informal experiences using technology; 2) the opportunity for students to extend their learning outside of school; and 3) the evidence of connections between students' self-directed interests and their schoolwork (DeGennaro, 2008; Franklin and Peng, 2008; Lawrence, McNeal, & Yildiz, 2009; Mouza, 2008; Silseth, 2012; Spires et al., 2008).

The authentic inclusion of students' ideas and informal experiences using technology can provide a contextual entry point for increasing student interest in learning (DeGennaro, 2008; Spires et al, 2008). In a situational case study on the use of instant messaging (IM) by students in an afterschool setting to communicate with their advisor-teacher, DeGennaro demonstrated how empowering students to share their ideas on technology usage resulted in increased student motivation and greater self-directed learning. By allowing students to identify the digital tool they thought would best engage them in the learning process (IM), the advisor-teacher validated the expertise and experience of the students and engendered increased engagement. Spires et al. in their analysis of middle school students' perceptions of academic engagement in classroom activities noted a similar result. Findings from student focus groups demonstrated that students believed that if their teachers would recognize the value of students' out of school usage, teachers would do a better job of incorporating technology within instruction. The students appreciated the potential of technology as an engagement tool and thus, they wanted their teachers to not only use more technology, but to use it *purposely* to engage them in learning.

Effective use of technology within classroom settings can act as the catalyst for increased engagement in learning when students are afforded opportunities to extend their learning outside of school using similar tools (Franklin & Peng, 2008; Mouza, 2008; Silseth, 2012). In a case study, Franklin and Peng explored the efficacy of using mobile devices to support classroom math instruction. In addition to the impact in the classroom, the researchers learned that the students independently accessed the class developed math videos outside of school to self-remediate themselves and to collaborate with classmates on projects. The students' engagement with the math learning process was deepened by their ability to self-direct their learning outside of school using the school provided mobile devices.

Similarly, Mouza (2008) observed how students in her mixed methods study of students' use of laptops in a predominantly urban, low-income elementary school used digital tools to extend their learning beyond classroom instruction. As a self-initiated activity, the fourth graders used their laptops to collect and report on changes in the outside temperature and then extended the learning process by conducting student polls and creating graphical representations as to how their peers were responding to temperature fluctuations such as by wearing a sweater or bringing an extra bottle of water to school. The technology enabled the students to self-direct the learning process while connecting the science concepts of weather and temperature with real world contextual meaning such as what to wear to school. The extension of learning can be bi-directional as evidenced by how students' engagement in a classroom based, game-enabled learning process is further enhanced when the students can bring into a game playing experience other contextual information that holds high personal interest to them (Silseth, 2012). The student-initiated supplemental information about the topic and the game created a more personalized context for the learning process, resulting in a stronger environment for student engagement in learning.

Connecting students' self-directed interests with schoolwork provides an effective bridge between informal and formal learning, and empowers greater student engagement in learning (Franklin & Peng, 2008; Lawrence, McNeal & Yildiz, 2009; Mouza, 2008; Silseth, 2012). An effective example is a study on the use of popular culture and technology within a remedial summer literacy program where at risk students read culturally significant but non-traditional literacy devices such as graphic novels, and produced and authored a digitally created comic strip around a social issue in their community (Lawrence, McNeal, & Yildiz). The responsive structure of these summer school activities provided room for the students to tap into their own prior knowledge of digital tools and to develop increased literacy skills within the context of creating culturally and personally meaningful content. The result was increased student engagement in the learning process and improved outcomes in both the traditional literacies of reading and writing and the new literacy of effective information and media use. Whereas research affirms that the access to digital tools can be potentially engaging for students, the literature also indicates that the context of the technology-enabled experience is an important component in creating engaging and academically meaningful learning. Understanding the context of the learning experience is in many ways analogous to realizing the purpose behind learning. When students have the opportunity to connect their self-directed interests to schoolwork activities, engagement is amplified though the realization of purpose and context (Franklin & Peng; Lawrence, McNeal & Yildiz; Mouza; Silseith). Unfortunately, too often educators do not understand or undervalue the critical importance of purpose and context when striving for more engaging learning experiences (Lai, Khaddage & Knezek, 2013).

Using technology to enable the workplace ready skills and literacies. Beyond student motivation and engagement in learning, many education leaders are also interested in the role of emerging technologies to support the development of workplace ready skills such as collaboration, critical thinking, creativity and communications. Wagner (2008) identifies these skills amongst a set of proficiencies that he terms the essential *Seven Survival Skills* (pg. 14). The recent literature provides examples of how a variety of digital tools and resources enable students to gain exposure and experience with these new literacies at school, in after school or summer programs, and at home. Several scholars examined how students' experiences with playing digital games developed critical thinking and collaboration skills (Ke, 2008; Silseth, 2012; Trespalacios, Chamberlain, & Gallagher, 2011). Other researchers explored the role of social media tools to support the development of 21st century literacies (Greenhow & Robelia, 2009b; Harlan, Bruce, & Lupton, 2012). A common denominator across the studies is the evidence that the students' engagement with technology outside of school provides additional value to the development of the workplace ready skills.

While conventional wisdom sees game playing activities as individualistic endeavors, recent research illustrates how an academically oriented game can be a shared experience amongst students and a potentially significant way to help students develop collaboration and critical thinking skills (Ke, 2008; Silseth, 2012; Trespalacios, Chamberlain, & Gallagher, 2011). Using an ethnographic case study of one student's learning trajectory playing a game about the Palestinian-Israeli conflicts, Silseth uncovered that the success of the game experience was enhanced for the student and the entire class when students' self-developed gaming literacies were valued and incorporated into the in-school experience. The studies by Ke (2008) and Trespalacios, Chamberlain, and Gallagher (2011) supported that same conclusion. In a summer math camp for fourth and fifth graders, Ke observed that collective game playing also facilitated greater peer communications but with some specific gender differences. The girls' communications were social in nature and supportive of collaborations while the boys focused on score reporting and tricks to get around obstacles in the game play. Working in a university based learning games research laboratory, Trespalacios, Chamberlain, and Gallagher also observed that middle school students preferred to play multi-player video games to single player games. Within the multi-player experience, the students enjoyed the task of reaching a goal within the game with another person and establishing social connections within the learning experience. As with the Silseth and Ke studies, the students' shared tips and strategies with each other from their personal game experiences to strengthen the collaboration environment within their game playing. This provided opportunities for the students to learn effective teamwork and collaboration skills within a context of a learning experience that was engaging and relevant.

Students' out of school participation in social networking sites and interest-driven online communities also facilitates student learning and practice of workplace ready skills and 21st century literacies (Greenhow & Robelia, 2009b; Harlan, Bruce, & Lupton, 2012). Students that were active participants in a social networking site developed more effective communications skills, most notably the ability to read an audience and present information in an appropriate way for that audience (Greenhow & Robelia). The researchers also noticed that students used their social networking site to support school task activities and provide peer-to-peer academic coaching and support. Another popular form of social media, the online community, also empowered students to develop sophisticated information literacy skills (Harlan, Bruce, & Lupton, 2012). The self-directed, interest-driven interactions of high school students in a variety of online communities are summarized as gathering information, thinking about that information, and then creating content using that information. The researchers concluded that it is in the process of creating online content that students learned new information and media literacies, modeled new practices online, and had esteem-building experiences as published authors, artists and composers. While some educators dismiss students' social media activities as trivial or only social in nature, Harlan, Bruce, and Lupton and Greenhow and Robelia provide interesting cases for examining how the use of these tools can create meaningful learning opportunities for students within traditional school environments while at the same time supporting the critical elements of competency and relatedness as described by self-determination theory.

In each of the aforementioned studies, the students' out-of-school experiences with technology influenced how they leveraged digital tools and resources to develop workplace ready skills and literacies. The ability of the students to adapt their informal uses of technology tools to formal education processes establishes a strong foundation for self-directed learning and their personal development as independent learners.

Using technology to empower self-directed learning. The concept of technology as a tool for developing student capacity for self-directed learning is at the core of Prensky's (2008) theoretical framework about the differences between today's youth whom he calls digital natives and the adults in their learning lives, the digital immigrants. According to his theory, digital natives have not only grown up immersed in technology, but their experiences with online games, mobile devices and social media tools outside of school has changed their expectations for using technology within school. Several researchers have expanded upon Prensky's theory by exploring how students want to use their personal online tools to support school learning activities (Clark, Logan, Luckin, Mee, & Oliver, 2009; Drexler, 2010; Fewkes & McCabe, 2012). The study by Clark et al. identified various ways that middle and high school students wanted to use informal technologies within formal learning contexts. However, the researchers also acknowledged that tensions exist between students and educators around the "perceptions of which activities are considered appropriate and pedagogically useful in learners' formal learning worlds" (Clark et al., p. 68). The empirical studies of Drexler and Fewkes and McCabe provide new evidence as to how digital tools that some educators may consider inappropriate for school use can empower self-directed learning.

When students are allowed to adapt personal online tools such as social media for use within school settings as learning tools, the results include increased engagement, development of college and career ready skills and increased personal capacity for self-directed learning (Drexler, 2010; Fewkes & McCabe, 2012). In a study of how a social networking site supported educational goals, high school students regularly used Facebook to communicate and collaborate with classmates on school related activities and tasks (Fewkes & McCabe). The students' informal successes with these interactions validated the students' strong belief in the potential value of Facebook as an effective educational tool within the school environment. In her study of how high school students used social media tools to develop personal learning networks, Drexler provided further support for this concept of technology as an enabler of independent learning. The in-school experience of constructing a personal learning network within a particular course of study empowered the student to apply this same model of learning to other discipline areas with less teacher guidance and a higher reliance on their own self-directed approach.

Student Interest Driven Digital Learning

Another common misperception that many educators hold is that student self-directed use of technology outside of school is only for entertainment or relationship development. A nascent set of research is emerging that presents a case for how students are using digital tools and resources to self-direct learning around academic interests and skill development of high personal value to them. Ito (2010) characterizes this interest-driven digital learning as learning experienced through interactions with peers that share similar interests and the ability for students to explore their identity, express themselves, give feedback to others and follow passions that not standard within school curriculums. In contrast to the use of technology in adult-sponsored learning spaces, within the student interest-driven paradigm, both content and modality is inherently student initiated and directed. The increasingly ubiquitous availability and access of new media tools to students is the fuel that is enabling this new learning paradigm.

Outside of adult fascination with students' adeptness in using new media, the real value in exploring this new research area is in terms of the impact of student interest-driven learning on traditional education environments. The old paradigms that differentiated formal and informal education are less relevant in a world where a student can almost simultaneously learn about a scientific breakthrough through a Facebook alert, send a Twitter message to the world broadcasting her thoughts on the discovery, and then seek out additional experts with only a few mouse clicks or swipes on a touchscreen. Barron (2006), Drotner (2008) and Greenhow and Robelia (2009a) express what many researchers in this new field are realizing: that what students are learning outside of school beyond the sponsorship of educators can have an impact on the teaching and learning that happens in the classroom. Understanding the learning lives of today's students and the impact of interest-driven learning on student identity and skill development is an important component of the research.

Frameworks of interest-driven digital learning. To provide a context for understanding the move beyond the traditional conceptions of formal and informal learning to a more diffused and digitally based paradigm, several researchers have leveraged their empirical findings to develop new frameworks of understanding around student interest-driven learning. A common thread across the various frameworks espoused by scholars in the field (Barron, 2006; Boyd, 2007; Erstad, 2012; Furlong & Davies, 2012; Greenhow & Robelia, 2009a; Ito, 2010) is the idea that situated learning, learning as an act of social participation that involves knowledge sharing, peer mentoring and communities of practice, is a key component of the students' desire to pursue learning within their own technology immersive contexts. Though still emerging as an area of research, the frameworks discussed by these researchers provide a valuable lens for exploring the impact of such learning environments on students, and how schools can address students' expectations for more self-directed, interest-driven learning experiences.

The concepts of time, place and setting, so revered and institutionalized within traditional education, have new meaning when discussing interest-driven learning, especially when technology supports the learning activity. Learning that is fueled by a combination of students' self-directed interests and appropriate digital tools transcends the traditional boundaries established by school and home and the result is a rich array of learning experiences that are seamlessly integrated throughout the student's day (Barron, 2006; Erstad, 2012). Dodge, Barab, Stuckey et al. (2008) refer to this virtual space as the *third place* for learning, beyond the physical spaces of school or even home. For today's student, learning does not exist in isolation but rather happens across a variety of settings and through a seamless flow of practices from morning to night. Various types of media and technology are often the conduit for this learning trajectory as illustrated by the student in Erstad's study who had a particular interest in photo editing. Throughout a typical day, the student manipulated photos from multiple sources to post to her personal blog, enhance a school assignment, support a family member's work project, and to develop her own technology fluency with new software. Erstad's *learning in motion* framework which describes how students operate in both physical and virtual spaces to support interest-driven learning is similar to Barron's *learning ecology* concept in that the student is able to extend interest and expertise across various settings.

However, Barron (2006) is also interested in the trigger point or spark for igniting this self-directed interest. In her ethnographic study of middle school students, she examined how different students' interests originated through a class at school, an informal learning experience or though family nurturing. Beyond the trigger point, students followed a typical pattern of seeking additional learning opportunities to support their new interests and then extending that interest and expertise as it developed across various settings. As explained by both Barron and Erstad (2012), the traditional boundaries between formal and informal education settings blur within the real world context of how students are using digital tools to support their own learning. Most schools however focus just on the ways and means associated with formal school learning environments and fail to see the relevancy or potential impact of students' self-directed experiences on their in-school experiences. This disconnect is not lost on the students themselves however (Spires, Lee, Turner & Johnson, 2008).

The imprecision of traditional terms such as formal or informal learning becomes increasingly visible within the new context of interest-driven learning. In their study of low-income students' perceptions and activities using social networking sites for both friendship and interest driven experiences, Greenhow and Robelia (2009a) introduced a differentiation between *informal* and *non-formal* learning to bring clarity to the discussion. An example of *informal learning* is when a student does an Internet search to find out how to upload a digital audio file to their Facebook site. If that student however seeks help from a friend or through an online forum on how to do that same task, that learning modality represents *non-formal learning*. Supporting this new concept of non-formal learning, a critical strategy for developing students' self-efficacy around interest-driven learning is the ability for students to share their newly developed expertise and co-learn with peers (Furlong & Davies, 2012). The characterization that interest-driven learning inherently includes knowledge sharing, peer mentoring and a community component underscores the relevancy of situated learning theory within this context.

Online communities and social networking sites facilitate student sharing of interests and expertise. Using ethnographic data collected during a two-year study of urban youth and their engagement with social networking, Boyd (2007) advanced the concept of *networked publics* as a new framework setting for both students' friendship driven activities as well as interest-driven learning. Social networking sites are examples of mediated networked publics where individuals can gather, exchange ideas, create identities and provide support to one another. The key properties of these networked publics are the persistence or forever quality of online communications, the ability to seek people that share your same interests, the replicability of content from one site to another, and the invisibleness of the larger audience (Boyd, p. 126). While Boyd's research examined how teenagers' use of social networking sites is helping them acquire skills for public behavior, Fewkes and McCabe (2012) demonstrated that students are also using social networking sites for peer communications and collaborations around schoolwork, and that the students believe that social networking sites have potential as learning support tools for their academic interests. Dodge, Barab, Stuckey et al. (2008) note that personal identity is often situated within the contexts and practices of how students engage with various digital media and most notably within online communities supported by social media. They shared a case study about a shy and quiet teen, Xia, whose development of her personal proficiency using communication technologies is an important driver of her emerging adolescent identity. Her participation in the online communities provides her with opportunities to express self-efficacy as a respected leader within that community, explore commitment setting with peers, develop meaning and context around her role, and engage in purposeful learning activities (pg. 234). Xia's actions therefore support the concept of using self-determination theory to explain students' self-directed learning. Her actions represented increased autonomy in her learning pursuits, the development of competence in skills and fostered connections or relatedness within her chosen community. All three studies point to the importance of studying students' behaviors within these participatory communities as the means to understanding how adults can support students' self-directed learning.

In her seminal work on how today's youth are living and learning with new media, Ito (2010) in collaboration with colleagues synthesized the research from 27 empirical studies that explored how students used emerging technologies such as social networking, games, online communities and digital media production tools to support friendship-driven learning and interest-driven learning. From the studies, the researchers identified three genres of participation (*hanging out*, *messing around and geeking out*) that describe students' varying levels of investment or participation in these new media tools.

At a minimal level of participation, students used social networking sites to hang out with one another in a modern day version of the "no adults allowed in" clubhouse of their parents' era. The *hanging out* genre inevitably included the simultaneous use of multiple digital tools as demonstrated in a study about youth participation in YouTube (Ito, 2010). Students regularly watched YouTube videos and TV shows on their computers while also simultaneously communicating with friends through social media who were watching the same videos and shows miles away at their own houses. The *hanging out* genre is an example of a friendship driven use of digital media where the primary goal is to maintain a connection with friends.

When students are *messing around* using digital tools and resources, they are beginning to explore an academic or skill based interest area and experiment with technology as a learning source (Ito, 2010). This learning process is self-directed as evidenced by how students in several studies searched the Internet for tips on how to play particular online games or tinkered with various digital media tools to teach themselves how to create a video. The hybrid nature of *messing around* where the friendship activities are still important but the students are interested in tapping into new media to explore interests has parallels with another student media usage model called *fiddling around* (Furlong & Davies, 2012).

The third genre of participation, *geeking out*, is characterized by a student's intensive interest and high level of personal investment in exploring a particular learning area and developing expertise in that area through the use of digital tools and resources (Ito, 2010). Teenagers interested in Harry Potter exhibited *geeking out* behavior when they learned how to create podcasts and videos on their own so that they could participate in fandom sites and share their perspectives and ideas about the books with others. The *geeking out* learning process for students is intrinsically self-directed and highly engaging, and yet for the most part, is not valued within traditional formal education as it often happens beyond the sponsorship of educators (Erstad, 2012; Ito, 2010; Prensky, 2008; Spires et al., 2008). Taken in concert with the frameworks from Erstad, Barron (2006), and Greenhow and Robelia (2009a), Ito's genres of participation of *hanging out, messing around and geeking out* provide a intriguing lens for analyzing the impact of new media and networked publics on the outcomes of students' interest-driven learning. In particular, the frameworks provide a context for understanding how students are using digital tools to acquire a learning identity and develop workplace ready skills.

Impact of interest driven digital learning opportunities. Empirical research on students' interest-driven learning is currently focused on two specific impacts. First, students' self-directed use of digital tools and resources to pursue their own academic interests is resulting in increased identity formation for those students as learners (Barron, 2006; Boyd, 2007; Erstad, 2012; Furlong & Davies, 2012; Greenhow, 2010; Greenhow & Robelia, 2009a; Ito, 2010; Squire & Dikkers, 2012). Second, by virtue of students' focused and intensive participation with these new digital tools, the students are also acquiring workplace ready skills and literacies highly valued by employers and the life skills needed to participate in networked publics (Boyd, Furlong, & Davies, Greenhow & Robelia; Ito).

One of the key attributes of interest-driven digital learning is the transition of the student from simply a media consumer to an empowered and useful media producer (Greenhow, 2010; Ito, 2010; Squire & Dikkers, 2012). As noted in Squire and Dikkers' study of students' use of smartphones for independent learning, the students highly valued being able to use their smartphone to seek information that interested them, to have that information available at their fingertips, and to be able to then remix and repackage digital content in highly personalized ways. For the student in the study who was interested in music, his smartphone enabled him to research songwriting techniques anywhere, anytime, but also to use the device to assist with his writing process through audio recordings and playbacks in his family's basement where he would not disturb others. This heightened sense of empowerment and value as a self-directed learner results in a greater "*amplification of self*" (Squire & Dikkers, p. 453).

Greenhow (2010) also saw the impact of the empowered learner with her research on students' creation of content for a youth-initiated, current events focused niche network within Facebook. Documenting that two-thirds of the content on the site within one three-month period was contributed by students, Greenhow noted that the act of contributing that content resulted in the student-writers having an increased interest in the topics they were reporting on such as environmental science and climate change. Squire and Dikkers (2012) refer to this result of self-directed learning as an "*amplification of interest*" (p. 456). By acting on their own interests and creating content that supports and extends these interests, students develop their own voice and agency as a learner and as a member of society (Ito, 2010).

Social networking sites provide valuable opportunities for students to explore their own identity both within society and as a learner (Boyd, 2007; Greenhow & Robelia, 2009a). One of the most appealing aspects of the sites to youth is their ability to develop and showcase skills within a network of like-minded peers (Greenhow & Robelia). Barron (2006) in her case study portraits of self-directed learners and Ito (2010) in several of the studies she analyzed with her colleagues demonstrated the linkage between students' development of expertise in the use of various digital media such as gaming, web design or video editing and their growing sense of self-identity and competence. The arenas where students are developing these new identities, gaining prestige and cultivating reputations as experts is very different than traditional academic performance-based settings. Student-sponsored arenas such as online communities for gamers and niche social networking sites have a solid foundation in peer learning, knowledge sharing, and a culture where failure is neither consequential nor has the high stakes ramifications of traditional school achievement measures (Ito, p. 213).

By using digital tools to create content around interest areas and developing expertise within those areas of interest, the students are also acquiring or enhancing many of the workplace ready skills that many educators already see as outcomes from the use of technology within the school setting, most notably, technology skills. Both Furlong and Davies (2012) and Greenhow and Robelia (2009a) see the development of technology fluency as a key byproduct of students' interest-driven digital learning. Within all three genres of participation, *hanging out, messing around and geeking out,* Ito (2010) documents how students are not only developing new technical skills by using digital tools but many are also serving as "techne-mentors" to each other by sharing resources and knowledge and actively functioning as online peer coaches. Similar to what Greenhow and Robelia (2009b) learned about how students are acquiring effective communications skills using a social networking site, Boyd's research (2007) found that students' use of these sites also provided important digital citizenship lessons on how to manage public impressions and read social cues from both written content and imagery.

The Internet has forever changed the way we think about public spaces and thus, the development of college and career ready skills as identified by the researchers represent a new set of life skills for today's youth. Today's students are on the leading edge of understanding how to merge personal identities around topics that interest and engage them with the development of meaningful life and workplace ready skills. For the most part, this critical learning process is happening outside of their formalized school environments. The students are self-directing this type of learning and thus in many ways, they are addressing the three basic psychological needs of autonomy, competence and relatedness espoused in Ryan and Deci's (2000) self-determination theory.

The Practical Application of SDT

Given the lack of maturity in the research field on the topic of student self-directed, interest-driven digital learning, it is not surprising that the research community is also struggling to identify primary theoretical frameworks to ground forward research. As discussed earlier in this literature review, self-determination theory provides a promising framework for understanding the value of intrinsic motivations. The application of that framework, especially for practitioners, requires additional context however. The work of both Pink (2009) and Wagner (2008, 2012) provide relevant perspectives for understanding student motivation in particular, and how such motivations can be harnessed to ensure that today's students have the skills they need for post-school success.

The application of Pink's (2009) theories on motivation helps us understand why students may be interested or motivated to pursue self-directed digital learning. It is human nature to be curious. Acting upon that curiosity requires a level of self-directedness and individual initiative in most cases. A student may learn in class that emergency medicine for example was a byproduct of how medical professionals learned to deal with trauma during the Civil War. However, if that student is curious about the types of traumatic injuries experienced in the battlefield or the products that were invented to support surgery under battlefield conditions, they may need to explore those topics on their own if they are beyond the scope of the class curriculum. The ability of the student to find appropriate and accurate information, resources and experts on this topic requires self-directed learning that is individually sponsored. The learner in this case is satisfying a desire for autonomy in the learning process. Taken to the next step, Pink also proffers that engagement in an activity such as learning is part of the process of developing mastery or competence, an important component of self-efficacy. Like Dweck (2006), Pink sees mastery as a specific mindset or way of thinking about one's abilities to learn (pg. 118). While autonomy and mastery are important components of motivation, the fuel that drives the engine for personal motivation is purpose. Similarly, Wagner (2012) also identifies purpose or the identification of intrinsic goals as a key component to understand how today's students are motivated differently, especially as it relates to school-centric learning.

Wagner's (2012) work on the ineffectiveness of traditional education to support the development of creative problem solving and innovative thinking skills is helpful to set additional context around self-directed learning, and potentially, the role of digital tools in that pursuit. At the heart of his argument is that traditional school environments are not focused on the skills that students need to be successful in the future, his *Seven Survival Skills* (2008). The traditional classroom rewards individual achievement rather than the success of collaborative efforts, is organized around communicating specific subject content rather than exploratory learning skills, and relies upon extrinsic motivations such as grades and test scores rather than the intrinsic motivators such as play, passion and purpose (pg. 57). In stark contrast is how today students, who Wagner calls the *Innovation Generation*, want to experience learning. Reminiscent of the results from Ito's (2010) studies, Wagner says that students want to learn through connections with others, self-directed discoveries, and creation of content or different ways to display their knowledge or skills. This type of learning experience Wagner believes allows students to become not just self-directed leaners but effective innovators armed with the requisite skills necessary to be successful in a global, information-intensive society. Whereas Pink provides the context for understanding how SDT drives personal motivation, Wagner establishes the importance of the self-directed skills for future success.

As demonstrated in various studies (Barron, 2006; Boyd, 2007; Erstad, 2012; Furlong & Davies, 2012; Greenhow, 2010, Greenhow & Robelia, 2009a; Ito, 2010; Squires & Dikkers, 2012) students' self-directed use of digital tools and resources to pursue their own academic interests results in greater self-efficacy as a learner and the development of the critical workplace skills and literacies discussed by Wagner (2012). While not explicitly using the language of Pink, Wagner or Ryan and Deci, the aforementioned studies document that autonomy of the learning process, the mastery of skills or content, and the connections with others around a central purpose are key components for students' motivations. An emerging body of work is however testing the explicit intersection of *self-determination theory* with various conceptual models for student motivation and self-regulation as a foundation for explaining students' interests in digital learning.

SDT Application within Educational Technology Research. Though limited in scope and quantity, a few literature reviews and targeted research studies have undertaken the application of SDT and intrinsic motivation concepts within the education technology space. Though not directly tied to my research questions, the emergent work of these researchers yielded new insights to inform my research strategy and methodology, particularly as it applied to testing the working hypothesis on the learning behaviors of *free agent learners.*

Anh's review of various theoretical frameworks to explain the effect of social networking sites on adolescents' social and academic development specifically identified the role of relatedness within SDT as a driver of positive outcomes (2011). Like others, he also bemoans the deficit of empirical research on the effects of social networking and social media on students' motivations and emphasizes the need for deeper studies that examine the role of communications and connectedness within new online cultures that support student development of social capital and new literacies (pg. 1444). McLoughlin and Lee (2010) support the same conclusions and talk about the importance of innovative pedagogies to recognize that students want active learning experiences that are social, participatory and supported by rich digital media. They see the potential for technology to cultivate self-regulated, independent learning, both within and outside of the classroom through the development of personalized learning environments (pg. 29). Though not utilizing SDT as an explicit framework, these conclusions echo the empirical findings of

Drexler (2010), Fewkes and McCabe (2012), and Ito (2010) discussed previously within this literature review.

Three recent studies provide an interesting foundation for examining the application of SDT within empirical research on the role of various technologies in supporting student motivations. Zhao, Lu, Wang and Huang (2011) studied how the components of SDT (autonomy, relatedness and competence) influenced high school students' motivations to use the Internet to pursue intrinsic goals of enjoyment and curiosity. Most notably, they looked at both student characteristics as well as contextual factors in their quantitative analysis including the role of the teacher and parent as influencers. Their findings have both theoretical and practical considerations for my research. First, they determined that SDT was useful for explaining the relationship between basic psychological needs and students' intrinsic motivations; in this case, to use the Internet as a regular school and home activity. However, they also revealed a strong correlation between students' feelings of competence using the technology and their motivation to use that technology. This has powerful implications for the social justice implications of my research as it underscores what other researchers have determined as well regarding the relationship between student skill development with technology and academic and opportunity equity (Barron, Walter, Martin & Schatz, 2009; Reinhart, Thomas & Torskie, 2011; Ross, Morrison & Lowther, 2012; Tripp & Herr-Stephenson, 2009). As will be described in the methodology section, additional data analysis within my study will examine students' use of various technologies outside of school from a perspective of both access to technology as well as their own self-assessment of their technology skill proficiency.

The action research team of Moos and Honkomp applied SDT to their analysis of student motivations within an Adventure Learning environment (2011). In this study, a middle school classroom teacher created a technology-infused Adventure Learning environment to accompany his ascent of Mt. Kilimanjaro in Africa. Using email, podcasts, satellite communications and GPS, his students were able to participate virtually in the climbing adventure with him in a way that supported an authentic context for their geography lessons. The research team then examined student motivations through a combination of a questionnaire calibrated to a standardized motivational scale and small group interviews with students. The specific lens for that motivational research was the three components of SDT; autonomy, relatedness and competence. Though highly specific in the use of particular technologies and learning modalities, this study has applicability to my research in two ways. First, it again validates how to use SDT to inform research design as well as data analysis. Second, it underscores the importance of being open to unintended byproducts or findings from studies about students' use of technologies. A key unanticipated finding from this study was that the students believed that the Internet was a more effective pedagogical tool for learning than their class textbooks (pg. 244). While that finding may not be a light bulb moment for many within the education technology sector, it revealed for that research team that they needed to be aware of their own assumptions on student preferences, expectations and aspirations for learning; a wise finding for all researchers examining student motivations.

In the final study included in this section of the literature review, Filsecker and Hickey (2014) utilized SDT and the theories of intrinsic and extrinsic motivations to explore the impact of external rewards in an online game on student motivations for learning. As noted earlier, many teachers continue to view digital online games as individualistic activities steeped in extrinsic goals such as public recognition and fame. Most recently, that has included the emergence of digital badging as an outward sign of competency. Within this study, Filsecker and Hickey explored the depth of intrinsic motivation including engagement within a class of 5^{th} graders playing an educational simulation game, Quest Atlantis. The researchers' analysis of quantitative data derived from the play activity (i.e. time on task log files, self-assessment of motivational factors, and comprehension of key concepts) used a combination of analysis strategies to correlate game play results with motivation, engagement and learning. Their results indicate that the use of extrinsic rewards (digital badging in this case) did not undermine the intrinsic motivations that the students shared for the learning experience. Within the realm of research on the relationship between education technology and student motivations, it is prudent to embrace both the intrinsic as well as the extrinsic motivations that are inherent within the use of these compelling and engaging digital tools.

As stated by Boote and Beile, "doctoral students must be scholars before they are researchers" (2005, pg. 11). This goal of this literature review is to provide a solid foundation of scholarship to support my research design, implementation and analysis. The review included a synthesis of literature that describes the central problem; the disconnect between how students are leveraging technology outside of school to support self-directed learning in contrast with how educators view the impacts of technology on student learning within formalized environments. This disconnect is evident in the types of research that are dominant in the field as well as the paucity of empirical studies on how, why and when students are tapping into digital tools to support personal interests and academic curiosities. Given the nascent nature of the field of student self-directed, interest-driven learning, the identification of a theoretical framework is helpful for providing a context or lens for the research study design and analysis. The review of literature on self-determination theory and corresponding discussions on intrinsic goals and motivations provided a foundation for understanding how to frame prior research studies to support my design and analysis plan. The methodology for the study therefore stands on the shoulders of both empirical research and a theoretical framework.

CHAPTER THREE: METHODOLOGY

Review of Study Purpose

For today's student, learning is not limited to the classroom or the afterschool program, but rather happens across a variety of settings and through a seamless flow of practices from morning to night. The increasingly ubiquitous availability and access of new digital tools and resources such as social media, mobile devices, online communities and games is the fuel that is propelling this new learning paradigm. However, as explained in the literature review, the scholarship on how students are using technology to support self-directed, interest-driven learning outside of school is limited. Beyond the inadequate number of studies undertaken, the literature also points to a preponderance of small-scale case studies, observations of student activities with singular types of technologies and sensationalized qualitative results that perpetuate rather than mitigate adult misunderstandings about students' motivations and aspirations for using digital tools to support learning (Drotner, 2008; Ross, Morrison & Lowther, 2010; Selwyn, 2007). Using the literature on student use of technology, both in school and out of school, and self-determination theory as a foundation, this study examined how students are tapping into digital tools to support self-directed learning, a cohort that are labelled as *free agent learners* within Project Tomorrow reports (2010). Additionally, the quantitative analysis examined the relationships between various student self-directed learning behaviors and defining characteristics such as gender, technology skill self-assessment, home Internet access and school community profile. The qualitative analysis answered the questions around whether these self-directed learning activities were purposeful and to what specific outcomes. Given the increasing interest that school and district leaders, as well as state and national policymakers, have with digital learning as a vehicle for stimulating education reform, the findings from this study provide valuable insights into students' digital learning outside of school. As many researchers have implied, those insights may help education leaders design and implement a new era of innovation in classroom practices (Fewkes & McCabe, 2012; Grant, 2011; Greenhow & Robelia, 2009a; Squire & Dikkers, 2012; Stevens, Satwicz, & McCarthy, 2008).

As a review, the primary research question driving the study is to identify the learning behaviors, characteristics and purposes of students who are using digital tools to pursue self-directed, interest-driven learning outside of school. To explore that primary question, this study examined the validity of a working hypothesis on the activities and values of the *free agent learner* derived from the literature and my previous research. The working hypothesis is as follows:

Students are exhibiting the characteristics and behaviors of free agent learners when they use digital tools, resources and content outside of school to self-direct learning around areas of academic passion or personal curiosity, and these activities align with the identifying characteristics of self-determination theory (autonomy, competence and relatedness) and demonstrate a purposeful reason for the self-directed actions.

Given this working hypothesis, the following two secondary research questions are central to driving this study. The intent of these two secondary questions are further explained with supplemental queries.

RQ1: How are students using digital tools, resources and content outside of school to self-direct learning?

- What tools are these self-directed learners using with regularity?
- Are there relationships between these self-directed behaviors that are significant to understanding this emerging phenomenon?
- Are there significant differences or similarities in these learning behaviors predicated on gender, technology skill assessment, home Internet access, student interest in a specific career field, or school community profile?
- How do the self-directed, interest-driven digital learning behaviors support self-determination theory?
- Are there relationships between students' self-directed learning behaviors and their attitudes about learning in general?

RQ2: What purposes are driving the ways students are using digital tools, content and resources outside of school to self-direct learning?

- What are the most common purposes identified by the students?
- Are there differences in the purposes stated by students for their self-directed learning activities that are based upon the type of tool used for the self-directed learning or school community profile?

Research Design

Overview. The study undertaken was a secondary analysis of a large-scale data set with a goal to test the working hypothesis about the *free agent learner* using quantitative and qualitative data collected from middle school and junior high students. The data set utilized was the Speak Up Project data collected via an online questionnaire October 6, 2014 through December 19, 2014. After data cleaning and removal of missing data, the resulting sampling was 133,212 cases. The analysis design was two-phased. In Phase I, the aggregated data collected nationwide was analyzed to answer the research question that identified the self-directed learning behaviors of the free agent learner. This was accomplished using a variety of descriptive analytical processes and correlation analysis. In Phase II, additional quantitative analysis was undertaken as well as an examination of qualitative data originating from an open-ended question on the survey. The Phase II data was analyzed to identify the purposes behind the self-directed, digital learning behaviors. Narrative data from students at six specific middle schools representing a diverse set of communities and student demographics was selected for a summative content analysis.

Data Collection.

About the Speak Up Project. The Speak Up Project is a large scale, annual research effort undertaken by Project Tomorrow, a national education non-profit organization, based in Irvine, California. The goal of the Speak Up Project is to inform local, state and national leaders about the views and aspirations of their stakeholders, namely K-12 students, teachers (in-service and pre-service), administrators, parents and community members, regarding digital learning and other timely education topics. The project began in 2003 with a small grant from the United States Department of Education to collect the ideas of students as input for a national education technology plan that was subsequently published in 2005. Since 2003, almost 4.5 million education stakeholders have contributed to the Speak Up Project by completing an online survey and/or participating in a focus group with peers. Education leaders use the annual data findings to inform plans, programs, policies and purchases.

Instrumentation Development. The primary data collection instrument used within the Speak Up Project is an audience-specific online survey. The Project Tomorrow staff develops the questionnaires with input from national, state and local thought leaders and practitioners in K-12 education. Each audience specific survey consists of 10-30 questions with responses in multiple choice, single choice or Likert formats. Additionally, the surveys contain one or two open-ended questions for narrative response. The survey items (questions and responses) are part of an item bank that is reviewed annually. Approximately 60 percent of the survey questions are consistent year to year for longitudinal trend analysis. For purposes of this study, I used data collected via the 2014 survey administered to students in middle schools and junior high schools. That particular survey instrument included 28 multiple choice, single choice or Likert format questions and 2 open-ended questions for students' written narrative response. A copy of the survey instrument is included in the Appendices.

To address the research questions, nine (9) specific questions were identified for analysis from the Speak Up survey instrument administered to students in grades 6-8. Table 1 identifies the survey questions and response choices, and aligns those questions to the specific research questions noted above. The statistical analysis activities undertaken to support each research question are also identified.

Table 1. Identification of Survey Items and Alignment to Research Questions

Research Question	Survey Item # and Text	Item Type and Response Choices	Statistical Analysis Undertaken
RQ 1: ***How are students using digital tools, resources and content outside of school to self-direct learning?*** Sub – Q: What tools are these self-directed learners using with regularity? Sub – Q: Are there relationships between these self-directed behaviors that are significant to understanding this emerging phenomenon?	Q23. How often do you engage in the following activities because you want to learn a skill or know more about something educational that interests you (but not just because it was an assignment or homework)?	5 part Likert scale of frequency: Never Rarely Sometimes Often All of the time *(Selected responses)* Research a website to learn more on a topic Watch a video to learn how to do something Post a question on a discussion board or forum Use social media to identify people who share my interests Use social media to learn what others are doing or thinking about a topic that interests me	Frequencies Normality Group Statistics • Means Pearson correlation

Table 1. Continued

Research Question	Survey Item # and Text	Item Type and Response Choices	Statistical Analysis Undertaken
		Find experts online to answer my questions Play an online game or virtual simulation activity Use online writing tools to improve my writing	
RQ 1: ***How are students using digital tools, resources and content outside of school to self-direct learning?*** Sub - Q: Are there significant differences or similarities in these learning behaviors predicated on gender?	Q2. Gender	Single response required Girl Boy	Frequencies Group Statistics • Means • Independent samples t-tests • Effect size
RQ 1: ***How are students using digital tools, resources and content outside of school to self-direct learning?*** Sub - Q: Are there significant differences or similarities in these learning behaviors	Q3. How would you rate your technology skills compared to other students in your class?	Single response required Advanced – I know more than others Average – I know about the same as others	Frequencies Group Statistics • Means • Independent samples t-tests • Effect size

Table 1. Continued

Research Question	Survey Item # and Text	Item Type and Response Choices	Statistical Analysis Undertaken
predicated on the students' self-assessment of their technology skills?		Beginner – I am still learning how to use technology	
RQ 1: ***How are students using digital tools, resources and content outside of school to self-direct learning?*** Sub - Q: Are there significant differences or similarities in these learning behaviors predicated on the students' access to the Internet at home?	Q9. What kind of Internet access do you have at home?	Multiple choice check box response *(Selected responses)* A slow Internet connection (like dialup through a landline) A fast Internet connection (like DSL, broadband or cable) No home access.	Frequencies Group Statistics • Means • Independent samples t-tests • Effect size
RQ 1: ***How are students using digital tools, resources and content outside of school to self-direct learning?*** Sub – Q: How do the self-directed, interest-driven digital learning behaviors support self-determination theory? Each of these valuations ties to a	Q22. As a result of using technology to support my learning ….	Multiple choice check box response *(Selected responses)* I collaborate more with my classmates I am participating more in class	Frequencies Group Statistics • Means • Independent samples t-tests • Effect size

Table 1. Continued

Research Question	Survey Item # and Text	Item Type and Response Choices	Statistical Analysis Undertaken
specific component of SDT: autonomy, competence or relatedness.		I am developing critical thinking and problem solving skills I am developing creativity skills	
		I spend more time mastering a skill or learning something I am able to learn at my own pace I have more control over my learning	
RQ 1: ***How are students using digital tools, resources and content outside of school to self-direct learning?*** Sub – Q: Are there relationships between students' self-directed learning behaviors and their attitudes about learning in general? Examines strength of relationship between the behaviors and the learning values	Q25: How much do you agree with these statements?	5 part Likert scale of agreement: Strongly disagree Disagree Neither agree nor disagree Agree Strongly agree *(Selected responses)*	Frequencies Group Statistics • Means Pearson correlation

Table 1. Continued

Research Question	Survey Item # and Text	Item Type and Response Choices	Statistical Analysis Undertaken
		I am learning things that are important to my future on my own outside of school I like learning when I can be in control of when and how I learn	
		I like learning how to do things I like learning about new ideas	
RQ 1: ***How are students using digital tools, resources and content outside of school to self-direct learning?*** Sub - Q: Are there significant differences or similarities in these learning behaviors predicated on the students' interest level in a science, technology, engineering or math field?	Q17. Many people around the world are interested in having more students pursue careers in science, technology, math, or engineering. Are you interested in a job or career in any of these fields?	5 part Likert scale of interest Not at all interested Somewhat uninterested Neither interested nor uninterested Somewhat interested Very interested	Frequencies Group Statistics • Means • Independent samples t-tests • Effect size

Table 1. Continued

Research Question	Survey Item # and Text	Item Type and Response Choices	Statistical Analysis Undertaken
RQ 2: ***What purposes are driving the ways students are using digital tools, content and resources outside of school to self-direct learning?*** Sub – Q: What are the most common purposes identified by the students? Sub – Q: Are there differences in the purposes stated by students for their self-directed learning activities based upon the type of tool used for the self-directed learning or school community profile?	Q28: Some students are using social media tools, videos and online games outside of school to explore or teach themselves about academic or school topics that interest them. How are you using technology outside of school to learn new things or skills? What are you learning about? What digital tools or resources are you using?	Open-ended response	Summative content analysis to determine tool used and purpose for the self-directed behavior
RQ 2: ***What purposes are driving the ways students are using digital tools, content and resources outside of school to self-direct learning?*** Using career exploration techniques as a proxy for purposeful activity, are there significant differences in the relationships between self-directed learning behaviors that are	Q18. How would you like to explore future careers or get prepared for a future job?	Multiple choice check box response Responses identified as *digital or online means for career exploration:* Learn about careers through social media Play an online	Frequencies Pearson correlation

Table 1. Continued

Research Question	Survey Item # and Text	Item Type and Response Choices	Statistical Analysis Undertaken
based upon students' interests in using digital versus traditional tools for that career exploration?		or video game to learn more about a career Learn about different jobs through "Day in the Life" videos Use mobile apps or websites to explore careers Responses identified as *traditional means for career exploration:* Go to an after school program Go on field trips to companies and meet successful people Learn from teachers that have worked in that type of job Let career professionals teach lessons at school	

Table 1. Continued

Research Question	Survey Item # and Text	Item Type and Response Choices	Statistical Analysis Undertaken
		Take a quiz to find out my career interests or strengths Participate in science and math competitions Work with mentors who can help me with planning my future Go to a summer camp (like space camp) Use technology tools to make things (like 3D printers and maker software)	

The questions selected for this study have been part of the Speak Up surveys for several years and have been subject to various validity tests over the years. Reflecting an annual organizational goal to enhance data analysis, the Project Tomorrow team revised several of the questions in terms of wording, readability levels and response types for the 2014 data collection process. As is a regular practice within Project Tomorrow, the 2014 student surveys were piloted in early September 2014. Ten middle and high schools representing diverse communities in ten different states administered a pilot version of the survey instrument during the first two weeks of September and provided opportunities for their students (approximately 350 students) to comment on specific questions and responses to inform the final instrument versions. Additionally, a focus group was conducted in Orange, California with a class of 28 seventh grade students to gain additional feedback. The purpose of each of these activities was to gain feedback on new items and clarification of Likert scales specifically. The process of authenticating the survey question text, responses and Likert scales with student participants is a typical Speak Up process and is significant for the development of an instrument with high validity and relevancy for this study.

Sample and Population.

The Speak Up Project data set is based upon a convenience sampling whereas schools and districts chose to participate and make the survey link available to their stakeholders. The convenience participation is not at the student level as schools and districts must register with Project Tomorrow to participate. They then provide their students with a unique password for entry to the online survey site. As Project Tomorrow provides schools and districts (as well as states) with their own locally collected data and the national aggregated data as benchmarks for comparative purposes, schools and districts are incentivized to have as many of their students, parents, teachers and administrators complete the surveys as possible. The vast majority of schools and districts that participate in Speak Up have their students complete the online survey in classrooms, computer labs or media centers during the school day. Based upon analysis of the participation statistics, 8,216 schools from 2,676 districts in all 50 states participated in Speak Up 2014, generating over 521,000 online surveys from K-12 students, parents, community members and educators (teachers, librarians, principals, district administrators, technology leaders). Approximately 175 schools had more than 50 percent of their student population complete the online surveys in fall 2014.

Each item response within the Speak Up collected data is tagged to a school, to a district and to a state identifier. Project Tomorrow uses the US Department of Education's National Center for Education Statistics (NCES) database to identify school and district demographics. For purposes of the data analysis for this study, it was important to identify schools in the study data set by locale codes so that the analysis could compare student data from different types of communities. Locale codes represent a classification system developed by NCES using Census Bureau data to describe a school's location such as large city, midsize suburb, fringe town or distant rural. The locale codes are located within the NCES Common Core of Data (CCD). Every school that participated in the Speak Up surveys is tagged with an identifying locale code, and then grouped into one of three categories; urban, suburb or town/rural. These categories are operationalized as follows:

Table 2. NCES Locale Codes for Data Analysis

Urban	Locale codes: 11, 12, 13	11: City, Large (urbanized area, principal city with population of 250,000 and more) 12: City, Midsize (urbanized area, principal city with population between 100,000 and 250,000) 13: City, Small (urbanized area, principal city with population of less than 100,000)

Table 2. Continued

Suburb	Locale codes: 21, 22, 23	21: Suburb, Large (outside principal city, inside urbanized area with population of 250,000 or more) 22: Suburb, Midsize (outside principal city, inside urbanized area with population between 100,000 and 250,000) 23: Suburb, Small (outside principal city, inside urbanized area with population of less than 100,000)
Town/Rural	Locale codes: 31, 32, 33, 41, 42, 43	31: Town, Fringe (inside urban cluster equal to or less than 10 miles from urbanized area) 32: Town, Distant (inside urban cluster more than 10 miles but less than/equal to 35 miles from urbanized area) 33: Town, Remote (inside urban cluster but more than 35 miles from urbanized area) 41: Rural, Fringe (rural territory less than/equal to 5 miles from urbanized area and less than/equal to 2.5 miles from urban cluster) 42: Rural, Distant (rural territory more than 5 miles but less than/equal to 25 miles from urbanized area and more than 2.5 miles but less than/equal to 10 miles from urban cluster) 43: Rural, Remote (rural territory more than 25 miles from urbanized area and more than 10 miles from urban cluster)

Within the schools that participated in Speak Up 2014 and had student surveys submitted, 30 percent were identified as urban, 30 percent suburb and 40 percent town/rural per the Table 2 data from the CCD database. The locale codes are used in two ways in the analysis of the Speak Up data for this study. First, in support of research question 1 and in particular, to address the sub-question regarding the types of tools that students are using to support their self-directed learning activities, frequencies were run based upon the locale codes tagged to the participating schools. This information provided insights into any potential differences in students' self-directed learning behaviors based upon school community type (i.e., urban, suburb, town/rural). Second, the locale codes were used to identify a diverse set of schools for the Phase II data analysis of the qualitative data originating from the open-ended survey question. In addition to having a balanced set of locale codes represented, schools were also identified based upon having a high percentage (70 percent or higher) of their schoolwide student population complete a Speak Up survey. In addition to being an important marker for data validity, this latter criterion is indicative that the district values the Speak Up data and is thus careful with the implementation of the survey process within their schools. Using these two criteria, 35 schools initially met the requirements to be potential candidates for further analysis. Upon further evaluation, data from six (6) schools was selected for the summative content analysis; two schools from urban codes, two from suburb codes, and two from town/rural codes.

As this study was a secondary data analysis of a pre-existing dataset with no identifying data per student, I requested and was approved for exempt status from the Institutional Review Board at California State University, San Marcos.

Data Analysis Overview

The data analysis approach was designed to address the research questions in a two-phased approach. In Phase I, the statistical analysis of the quantitative data set originating from 133,212 middle school students who completed a Speak Up online survey focused on addressing the research question, *"How are students using digital tools, resources and content outside of school to self-direct learning."* Phase II analysis included both additional statistical analysis of the quantitative data set used in Phase I as well as a summative content analysis of written narrative responses from students in six middle schools. The goal of the Phase II analysis was to investigate the second research question, *"What purposes are driving the ways students are using digital tools, content and resources outside of school to self-direct learning."* As research is interpretational and iterative in nature, results from the analysis in Phase I informed the specific statistical activities in Phase II.

Phase I Analysis. Using SPSS 22 for the data analysis, a variety of statistical tests were completed that were appropriate for the data. The purposes of these particular statistical tests were to identify the following:

- Distribution of the frequencies by several independent variables
- Normality of the distribution of the self-directed learning behaviors
- Statistically significant differences between sub-segments of students relative to their self-directed learning behaviors
- Statistically significant differences between students' valuations of digital learning and their self-directed learning behaviors
- Strength and direction of the relationships between the self-directed learning behaviors
- Strength and direction of the relationship between the self-directed learning behaviors and students' attitudes about learning in general

Each of these tests provided new insights into how students are using digital tools, resources and content outside of school to self-direct learning. These insights are described fully in chapter 4. Equally important, these quantitatively-derived insights extended and elaborated upon the mostly qualitative, case study work of prior researchers such as Ito and her colleagues (2010). In addition, the analysis of the significance of statistical differences in students' valuations of digital learning and the likelihood of those students' exhibiting self-directed learning behaviors further extended the emergent and recent work linking self-determination theory to digital learning (Ahn, 2011; Filsecker & Hickey, 2014; McLoughlin & Lee, 2010; Moos & Honkomp, 2011; Zhao, Lu, Wang & Huang, 2011).

To enhance the validity of the findings, effect size testing was also done to provide further insights beyond the independent samples t-tests. This additional testing allowed for greater understanding of the size of the difference between the two groups tested (such as boys versus girls) rather than simply if the difference was significant or not. This is particularly recommended in large samplings such as the one used in this study (Coe, 2002). To operationalize the effect size testing, an excel-based calculator was downloaded from the RStats Institute at Missouri State University. The calculator used data derived from the SPSS calculations to determine various effect size results. This study used the Cohen's *d* effect size produced by the calculator in evaluating the size of the effect.

Phase II Analysis. The Phase I analysis provided a comprehensive understanding of how students were using digital tools beyond the classroom to self-direct learning, and the significance of differences between sub-segments of the student population.

Additionally, the correlation analysis increased our understanding of the potential relationships between students' valuations of learning in general and their self-directed, digital learning behaviors. Leveraging these insights for our analysis in Phase II, our goal in this work was to examine the purposes behind students' self-directed learning activities.

The analysis in Phase II involved two distinct efforts. For the first effort, a summative content analysis was done on the open-ended, narrative text written by students in six (6) middle schools in response to the question, *"Some students are using social media tools, videos and online games outside of school to explore or teach themselves about academic or school topics that interest them. How are you using technology outside of school to learn new things or skills? What are you learning about? What digital tools or resources are you using?"* In total, 3,253 written responses to that question were analyzed to answer these two key questions:

1. What digital tools, resources or content did the students say they used to self-direct their learning?
2. What did students say was the purpose for that activity?

The methodology for analyzing that data followed a summative content analysis (Hsieh & Shannon, 2005) approach in that it started with identifying certain words in the student narratives that indicated a particular digital tool (games, videos, websites, and social media) was used to self-direct learning. These four words/phrases (or codes) were indicated by our Phase I analysis as the most common digital tools that students were using to self-direct learning. The frequency of those words appearing in the students' responses was also calculated. However, further analysis of the text brings the interpretational element into the process. Driven by the research questions, it is imperative that the analysis went beyond the mere calculation of frequency of word use in the students' responses. It was necessary therefore to analyze the students' responses to understand why they were using these digital tools to self-direct learning on their own time; to identify the purposes of those activities. To achieve that deeper understanding, the next step in the process was to gain a broader perspective on the students' reflections on their goals or purposes, prior to additional coding. This approach of understanding first the landscape of student responses required a comprehensive reading of each set of student responses several times prior to developing any preliminary codes for analysis. To accomplish this I followed constructivist grounded theory techniques to reveal deeper meaning within the students' responses. After a highly iterative process of examining the students' responses and testing various coding schema, four primary purposes emerged from the analysis of the student responses. As the qualitative data was already tagged by grade level and NCES locale code, comparative analysis of the findings along those variables was also undertaken.

One of the primary purposes identified through the analysis of the students' responses was "career exploration." As explained by the students, their research into websites and through social media allowed them to learn about careers or jobs. For example, one student talked about watching videos of surgeries to gain a better understanding of what it meant to be a surgeon. To further explore this question around purpose, an analysis of quantitative data derived from the following Speak Up survey instrument question was completed: *How would you like to explore future careers or get* *prepared for a future job?* This item and its resulting data served as a proxy statement for additional quantitative analysis around students' purposeful self-directed learning; in this case, about how to explore future careers. The question format was a multiple choice response. Four potential responses indicated an online or digital activity:

- Learn about careers through social media
- Play an online or video game to learn more about a career
- Learn about different jobs through "Day in the Life" videos
- Use mobile apps or websites to explore careers.

The other potential responses represented more traditional activities such as attending a summer program or doing an internship. The purpose of this analysis therefore was to understand the strength of the relationship of the self-directed learning behaviors relative to the students' aspirations for career exploration, be it through digital or traditional measures. To accomplish this, Pearson product-moment correlation coefficient calculations were undertaken.

The Phase II analysis and derivative insights into why students are self-directing learning outside of school is important as it supports the application of SDT in two specific ways. First, the findings of purpose provide a tangible context for Pink's theories on motivation (2009) and confirm the self-determination need for autonomy and competence. Second, the findings corroborate Wagner (2012) in his theories on how students want to experience learning through collaborations and connectedness with others (or relatedness in SDT terminology), and the importance of students' enhanced capacity for developing the skills they need for future success.

Limitations

Limitations on generalizability or applicability are inherent within all research studies. For this particular study, I identified two specific limitations to be aware of and mitigate if possible during the data analysis phase of the study.

First, while the Speak Up 2014 data set is very large, it is a convenience sampling and some may question the generalizability of that sampling type. As noted earlier, the convenience sampling is at the school or district level, not at the student level. Thus, any potential bias within the data toward students who are technology sophisticates is minimized since school and district leaders make the decision to have their students take the survey. To mitigate that claim further, however, my Phase II quantitative data analysis focused exclusively on schools where over 75 percent of the school population completed the survey. Additionally, the analysis included tests for normality as well as an examination of correlations looking at the relationship between students' self-directed digital learning and their self-assessment of their technology skills as well as their access to the Internet at home. The discussion of the findings explicitly explains the steps taken to avoid any technology bias within the study population.

The second potential limitation of the study is a perception that my own positionality as a researcher and advocate for digital learning for almost twenty years will affect the interpretation of the findings. To that point, I wholeheartedly agree. The way I approached the findings was shaped by my prior experiences in analyzing the Speak Up data over the past thirteen years and conducting over 30 focus groups and panel discussions with students about their technology use, both in school and out of school, each year. However, rather than assuming that my positionality would mean a rose-colored glasses' approach to the data findings, I believe that the opposite is more accurate. Given my in-depth familiarity with the issues discussed in the literature and in the Speak Up data to date, my typical posture has always been to question quick assumptions regarding students' digital activities and to examine any data from the Speak Up Project or other sources with a highly objective and analytical approach to uncover deeper meaning. I employed that same approach with the analysis and interpretation of the data used within this study. However, given the reality of perceptions, it was important for me to be aware of all of my own implicit as well as explicit assumptions and to use publicly recognized analytic tools to support the study findings.

CHAPTER FOUR: RESULTS

Introduction

The primary research purpose of the study was to identify the learning behaviors, characteristics and purposes of students who are using digital tools to pursue self-directed, interest-driven learning outside of school. The research questions are:

RQ1: How are students using digital tools, content and resources outside of school to self-direct learning?

and

RQ2: What purposes are driving the ways students are using digital tools, content and resources outside of school to self-direct learning?

To explore these primary questions, the study examined the validity of a working hypothesis on the activities and values of the *free agent learner* derived from the literature and my previous research. The working hypothesis is as follows:

> *Students exhibit the characteristics and behaviors of free agent learners when they use digital tools, resources and content outside of school to self-direct learning around areas of academic passion or personal curiosity, and these activities align with the identifying characteristics of self-determination theory (autonomy, competence and relatedness) and demonstrate a purposeful reason for the self-directed actions.*

To test this hypothesis, the study conducted a secondary analysis of a large-scale data set using quantitative and qualitative data collected from students in grades 6, 7 and 8. The data set utilized was the Speak Up Project data collected via an online questionnaire administered to the students during the time period of October 6, 2014 through December 19, 2014. The analysis design was two-phased with each phase focusing on a secondary research question. Phase I data analysis focused on the research question, "How are students using digital tools, resources and content outside of school to self-direct learning?" The work of Phase I involved analysis of the aggregated quantitative data collected nationwide (133,212 cases) to identify the self-directed digital learning behaviors and the characteristics of the students exhibiting that behavior set. Phase II data analysis focused on the research question, "Why do students use digital tools, resources and content outside of school to self-direct learning?" The Phase II data, which included quantitative data from the national data set as well as qualitative, narrative responses from 3,253 students attending six (6) selected middle schools was analyzed to identify the purposes behind the self-directed, digital learning behaviors.

The function of this chapter is to present the results from the statistical analysis of the extant data used in this study. The chapter is organized around the two secondary research questions with the statistical data outputs presented in a sequential manner with Phase I results preceding the presentation of the Phase II results. Each section starts with a description of the specific sample used for that phased analysis. Statistical test data is shared using a common four step sequence: 1) state the research question driving this test, 2) identify the statistical test conducted, 3) provide the testing results, and 4) describe briefly the importance or significance of these results as they relate to the specific research question. Where appropriate, tables and figures are used to illustrate the results. The detailed discussion of the interpretation of the data results is covered in the following chapter including a comprehension evaluation of the implications of this study and its findings for school and district leadership. Additional implications are also noted for policymakers and education researchers.

Who are the students in this study? Identifying the sample population and key defining characteristics of that population is important for understanding the generalizability of this emerging trend amongst middle school students and providing a context for the subsequent statistical tests. The sample used within the Phase I analysis included 133,212 students in grade 6 (36.8%), grade 7 (32.7%) and grade 8 (30.5%) who completed a Speak Up online survey administered by their school in fall 2014. The schools who participated in Speak Up 2014 included schools identified as urban per the NCES locale codes (30%), suburb (30%) and town/rural (40%). Data used in the statistical tests in Phase I was from the nationally aggregated data set.

Several specific characteristics or assets associated with this national population were identified for use in additional statistical tests. These characteristics, gender, self-assessment of technology skills and interest in a STEM career field, were chosen for specific reasons to understand the sample population. Common perception is that boys are more interested in technology than girls are. Students with advanced technology skills are assumed to be using technology in all areas of their lives. Students with lower technology skills are assumed to be not participating in the information-intensive global society. It is also a widely held belief in schools and society that students interested in a science, math and engineering topics in school and have a greater interest in a STEM career field are more interested in the use of technology outside of school as well. What is not known today is if these commonly held perceptions are valid when discussing students' self-directed digital learning behaviors outside of school. The comparative analysis within this study will examine that. The frequencies of those characteristics therefore are important to note in this description of the student population.

Of the national sample, 49.3% identified as girls and 50.7% as boys. When asked to assess their technology skills compared to their peers, 27.3% of the students in this sample chose the response, “Advanced – I know more than others.” Two-thirds of the students noted that their skills were average compared to others (67.2%) and 5.5% chose the beginner designation.

The middle school students identified on the survey their level of interest in pursuing a career field in a science, technology, engineering and math (STEM) career field. Levels of interest were captured using a 5-part Likert scale of agreement. Within the national middle school student population, 28.5% said they were *very interested* in a STEM career field, 36.7% noted their interest level as *somewhat interested*. For purposes of the analysis within this phase, students indicating the levels of “somewhat interested” and “very interested” were combined to represent the sub-segment of the student population with an interest in a STEM career field. The comparative non-interested sub-segment of students included students who said they were not at all interested in a STEM career field (13.4%), somewhat uninterested (10.1%) and neither interested nor uninterested (14.0%).

Students also self-reported on their access to the Internet outside of school. Home Internet access has been used as a proxy by many researchers as an indicator of home poverty. Since the Speak Up survey does not ask students about their participation in other home poverty indicators such as the federally funded free or reduced lunch program, this item stands as my proxy for determining this important characteristic of this sample population. Within this national sample, 48.5% of the students indicated that they had a “fast Internet connection (like DSL, Broadband or cable),” 9.1% chose the response of a slow Internet connection and 6.2% said that they had no home Internet connection and only used free Internet services such as at the public library, afterschool programs or a WiFi hotspot in a public location. The balance of the students’ responses included various mobile data plans or home Wifi connections.

For the Phase II investigation addressing the research question about the purposes of students’ self-directed digital learning, six (6) schools serving students in grades 6, 7 or 8 were identified from the same Speak Up database used in the Phase I activities. Using criteria of having over 75% of their school population complete a Speak Up survey in fall 2014, 35 schools were identified as potential participants for the Phase II analysis. The six (6) schools ultimately selected for further study met the criteria of high student population participation in the surveys (ranging from 75% to 99%) and presented an opportunity to explore the research questions across a diverse set of school demographics. It was important for the study that students representing a variety of backgrounds based upon racial/ethnic heritage and family income be included in the analysis. The six schools include two from urban communities, two from rural/town communities and two schools classified as suburban. Two schools serve a school population that is majority Latino. Four of the six have over 50% of their students qualifies for the federally funded free lunch program, an indicator of family poverty. Table 3 provides the descriptive statistics on the demographics of the student population within the six study schools.

Table 3. Descriptive statistics about the study schools in the Phase II analysis

School Identifier	NCES Locale Code Description	State	Ethnicity					% of students eligible for free lunch program
			A/PI	B	H	W	Other	
A	City, Large (11)	Arizona	3%	1%	9%	82%	5%	2%
B	City, Large (11)	Nevada	3%	13%	69%	11%	3%	71%
C	Suburb, Large (21)	Maryland	3%	37%	9%	44%	6%	56%
D	Suburb, Large (21)	Texas	0%	0%	99%	1%	0%	94%
E	Town, Distant (32)	Indiana	0%	1%	1%	94%	4%	51%
F	Rural, Distant (42)	North Carolina	1%	13%	10%	71%	6%	28%

Note. Ethnicity labels are as follows: A/PI = Asian, Pacific Islander, B = Black, H = Hispanic, W = White, Other = American Indian and 2 or more races identified

Who qualifies as a free agent learner? For purposes of this study, the universe of all students is identified as exhibiting some level of self-directed, interest-driven learning behaviors outside of school using digital tools, content or resources. This assumption is based upon the work of several leading researchers in this area (Boyd, 2007; Erstad, 2012; Furlong & Davies, 2012; Ito, 2010; Prensky, 2008) and the examination of the frequencies of the behaviors identified through the Speak Up dataset. Table 4 illustrates the distribution of the national data set of students' participation in the self-directed digital learning behaviors identified for this study. A similar pattern of participation exists also when examining the students' responses based upon their community profile (urban, rural/town, suburb).

Table 4. Distribution of students' participation in self-directed, digital learning behaviors

Frequency of participation in the self-directed behaviors	Never	Rarely	Sometimes	Often	All of the time
Research a website to learn more on a topic (N = 107964)	12.8%	20.6%	37.5%	20.5%	8.6%
Watch a video to learn how to do something (N = 105770)	8.2%	14.9%	32.4%	28.3%	16.2%
Post a question on a discussion board or forum (N = 105273)	57.4%	19.9%	13.6%	5.6%	3.6%
Use social media to identify people who share my interests (N = 106010)	45.7%	16.9%	17.9%	10.9%	8.8%
Use social media to learn what others are doing or thinking about a topic (N = 105466)	41.5%	18.0%	19.9%	11.3%	9.3%
Find experts online to answer my questions (N = 105347)	48.6%	20.3%	17.4%	8.5%	5.2%
Play an online game or virtual simulation activity (N = 105237)	24.1%	20.3%	26.4%	16.3%	12.8%
Use online writing tools to improve my writing (N = 104918)	42.1%	21.3%	19.4%	9.8%	7.3%

The most frequently reported behavior is to watch a video to learn how to do something with 76.9% of the middle schools indicating that behavior as a regular activity, interpreted as doing it *sometimes, often and all of the time*. The least frequently reported behavior is to post a question on a discussion board or forum with 57.4% of the students saying that they *never* do that. However, for that same behavior, 22.8% of the students also noted that they do this behavior *sometimes, often or all of the time*. Thus, it does not appear that high participation in the activity measured by regularity is the best metric of including or excluding students from the free agent learner classification.

This chapter will examine how the levels of participation, regularity of that participation, and the digital tools used to support the self-directed learning may differ across the spectrum of students. Most importantly, this chapter will provide evidence that the defining characteristic of who qualifies as a free agent learner is not based upon frequency or regularity of the behavior, or the sophistication of the digital tools used, but rather that the self-directed, interest-driven learning is purposeful and serves to satisfy students' needs for realizing autonomy, competence and relatedness in their out of school learning lives.

Phase I Results

The goal of the Phase I data analysis was to examine how students use digital tools, resources and content outside of school to self-direct learning. To understand the lived experiences of middle school students in terms of their out-of-school digital learning lives, four subsequent questions were examined through the data. Those four questions are as follows:

1. What digital tools are students using to self-direct learning outside of school around academic or personal interests? This question identifies the frequency of the use of various digital or online tools to support self-directed learning. Students indicated on the survey instrument the frequency of their usage of these tools for self-directed learning using a 5-part Likert scale of never, rarely, sometimes, often, and all of the time. The use of the digital tools for purposes of this study is considered self-directed learning behaviors. Two subsequent statistical tests were conducted to assess the normality of these self-directed learning behaviors across the middle school population, and to examine for any

statistically significant relationships between the various digital tools used to support the self-directed learning behaviors.

2. What is the significance of student characteristics or assets on the self-directed digital learning behaviors? The specific student characteristics or assets analyzed to address this question were a) gender, b) access to the Internet outside of school, c) self-assessment of personal technology skills, and d) interest in a career in a science, technology, engineering or math (STEM) career field. The goal with this question was to understand if there are statistically significant differences in students' self-directed learning behavior based upon these specific characteristics (gender, technology skill assessment, STEM career interest) or assets (access to the Internet outside of school).
3. Are there relationships between various self-directed digital learning behaviors and students' attitudes about learning? Four statements about learning were identified from the data for examination. The data was collected using a five part Likert scale of agreement with the statement. Examination of the direction and strength of any relationships between the self-directed learning behaviors and the attitude statements provides potential new insights into the value associated with self-directed learning.
4. Do self-directed digital learning behaviors support the tenets of self-determination theory (SDT)? Students were asked on the survey to choose responses that were true for them about the value of using technology within learning. Six of the items connect to the core elements of SDT; relatedness, competence and autonomy. Tests were conducted to understand if there are

statistically significant differences in students' self-directed learning behaviors based upon the value statements chosen by the students.

What digital tools are students using to self-direct learning? The Speak Up survey instrument asked students about the frequency of using various digital tools, content and resources to learn a skill or know more about something educational that interested them. The question specifically indicated that the students' responses should not include specific homework or school assignments. The question employed a 5-part Likert scale of frequency (never, rarely, sometimes, often, all of the time). The scale of frequency was tested in advance of the survey process with middle school students as explained in the methodology section of this study. There were 11 items as response options. For this study, eight (8) items were selected for further analysis. Based upon a review of the frequencies of the entire 11 items, the eight selected items were the most commonly used by the middle school student population, both within this 2014 data set and prior Speak Up data sets as well. Each item represents either a specific digital learning tool (i.e., website, video, online game) or the use of that digital learning tool for a differentiated purpose (i.e., use of social media for two different purposes). The eight (8) selected items that were used to determine the characteristics of the self-directed digital learner are referred to as Learning Behaviors, numbered as LB #1 through LB #8:

- Research a website to learn more on a topic (LB #1)
- Watch a video to learn how to do something (LB #2)
- Post a question on a discussion board or forum (LB #3)
- Use social media to identify people who share my interests (LB #4)

- Use social media to learn what others are doing or thinking about a topic that interests me (LB #5)
- Find experts online to answer my questions (LB #6)
- Play an online game or virtual simulation activity (LB #7)
- Use online writing tools to improve my writing (LB #8)

Two levels of analysis are important to understanding what digital tools students are using to self-direct learning. First, the distribution of the frequency of the self-directed digital learning behaviors undertaken by the middle students was evaluated for normality. Table 5 presents a summary of the descriptive statistics including mean, standard deviation, skewness and kurtosis.

Table 5. Summary descriptive statistics on the frequency of the self-directed digital learning behaviors

Self-directed digital learning behavior	N	Mean[a]	Std. Deviation	Skewness		Kurtosis	
	Statistic	Statistic	Statistic	Statistic	Std. Error	Statistic	Std. Error
LB #1	107960	2.92	1.22	-.013	.007	-.621	.015
LB #2	105766	3.29	1.15	-.275	.008	-.632	.015
LB #3	105271	1.78	1.10	1.339	.008	.912	.015
LB #4	106002	2.20	1.35	.753	.008	-.721	.015
LB #5	105460	2.29	1.35	.651	.008	-.827	.015
LB #6	105431	2.01	1.21	.962	.008	-.152	.015
LB #7	105233	2.73	1.33	.207	.008	-1.079	.015
LB #8	104912	2.19	1.28	.771	.008	-.535	.015

[a]Minimum statistic for mean is 1.0 (never on the scale), maximum statistic is 5.0 (all of the time on the scale)

Given that the sample size is large, evaluating skewness, a common statistical technique for assessing normality, is less relevant as skewness is too sensitive for use in large sample sizes (Tabachnick & Fidell, 2013). Rather researchers recommend inspecting the shape of the distribution using a histogram. A histogram was created for each self-directed digital learning behavior providing a graphical illustration of the distribution of students' frequency in participation in that behavior. Interpretations of the distribution curve indicate the normality of the distribution. Figures 1 through 8 provide the histogram graphical representation of each learning behavior. As evident from the means analysis conducted (Table 5) the normality of the learning behaviors is variable. The following histogram figures help to illustrate that variability.

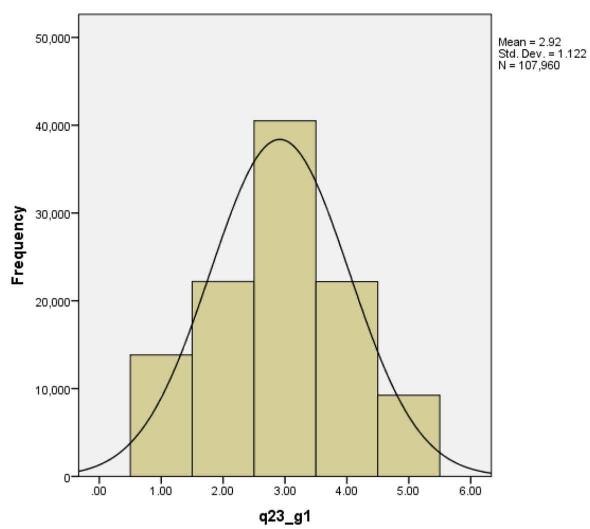

Figure 1. Normality of the frequency of students' researching a website to learn more about a topic

This histogram depicts a relatively normally distributed or symmetric set of data. The frequency of this learning behavior (researching a website) is normally distributed with an almost equal distribution of students that are participating in this type of self-directed digital learning as those that are not.

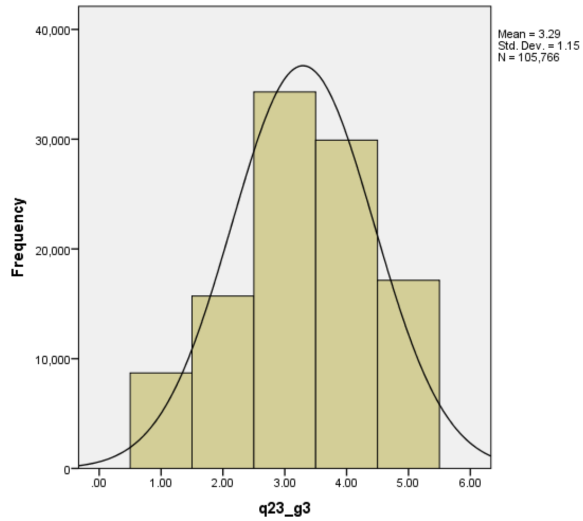

Figure 2. Normality of the frequency of students' watching a video to learn how to do something

This histogram denotes that the data is slightly negatively skewed left. This indicates that this self-directed learning behavior (watching a video) is done more frequently than a normal distribution would expect.

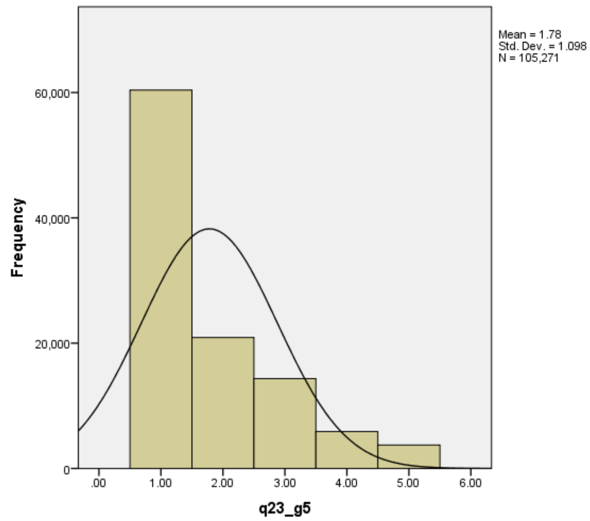

Figure 3. Normality of the frequency of students' posting a question on a discussion board or forum

This histogram denotes that the data is positively skewed right. This indicates that this self-directed behavior (posting a question) is done less frequently by the majority of students with relatively few doing this activity on an often or all of the time basis.

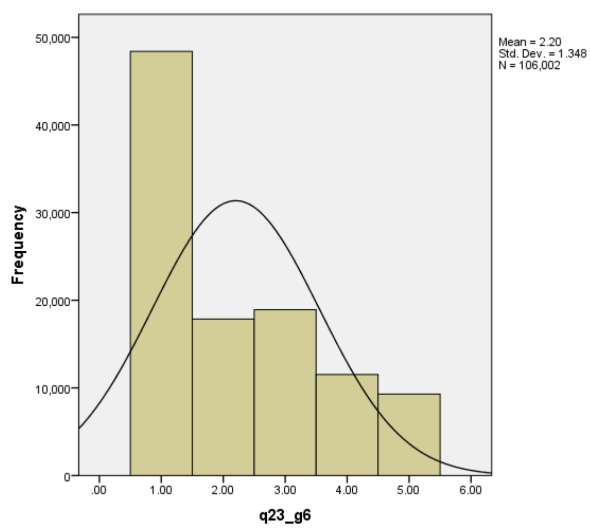

Figure 4. Normality of the frequency of students using social media to identify people who share their interest

The distribution curve is skewed positively to the right in the histogram for this learning behavior. However, the tail fall off distribution is not extreme. This means that while a majority of students is not frequently doing this activity there is a sizeable group of students for which this activity is frequent or at least occasional.

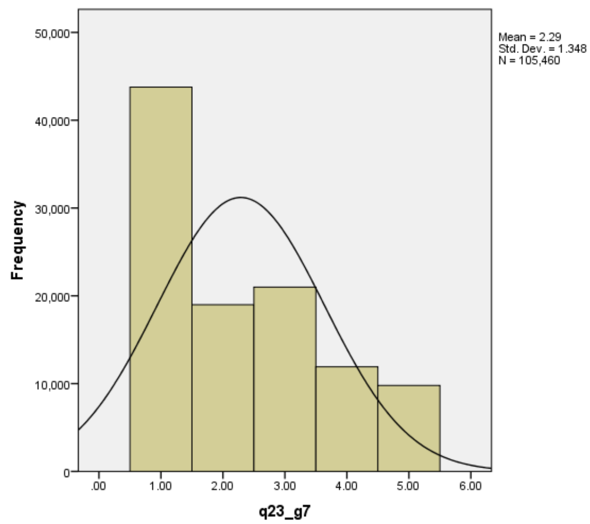

Figure 5. Normality of the frequency of students using social media to learn what others are doing or thinking about a topic that interests them

This histogram identifies that the distribution is skewed positively to the right in a similar pattern to the other social media oriented learning behavior as noted in Figure 4. As in Figure 4, the tail fall off distribution is not extreme. This means that while a majority of students are not frequently doing this activity there is a sizeable group of students for which this activity is frequent or at least occasional. The similarity in the histogram shapes in Figure 4 and Figure 5 also indicates that these two self-directed, digital learning behaviors may be positively correlated to each other. That is further explored in our second set of statistical tests on the frequency of the students' participation in these digital behaviors.

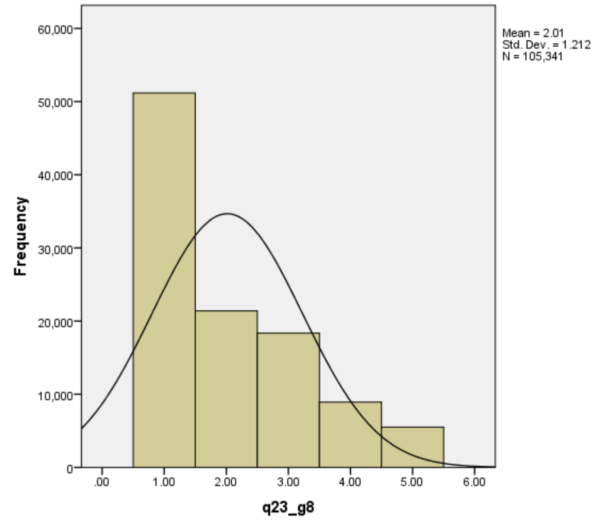

Figure 6. Normality of the frequency of students finding experts online to answer their questions

This histogram identifies that the distribution is skewed positively to the right. This indicates that this self-directed learning behavior is infrequent with only a small percentage of students participating in this type of an activity on a frequent basis.

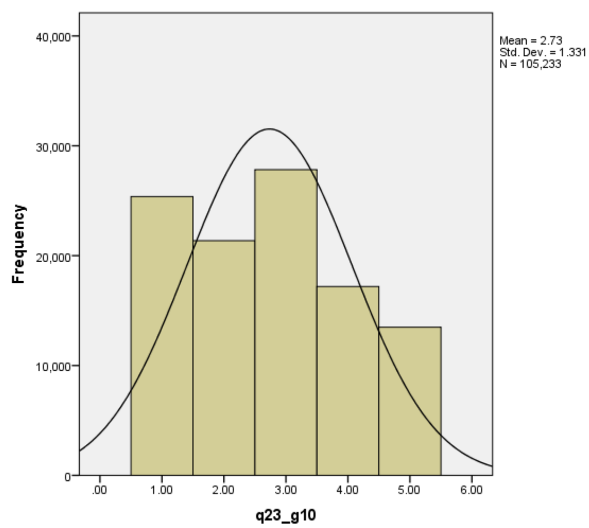

Figure 7. Normality of the frequency of students playing an online game or virtual simulation activity

This distribution is slightly skewed positively to the right. While the distribution is not symmetric the usage is approximating a normal distribution curve with the highest participation in the center (frequency of "sometimes") and the higher levels of participation (frequency of "often" and "all of the time") only slightly less than the less frequent levels ("rarely" and "never").

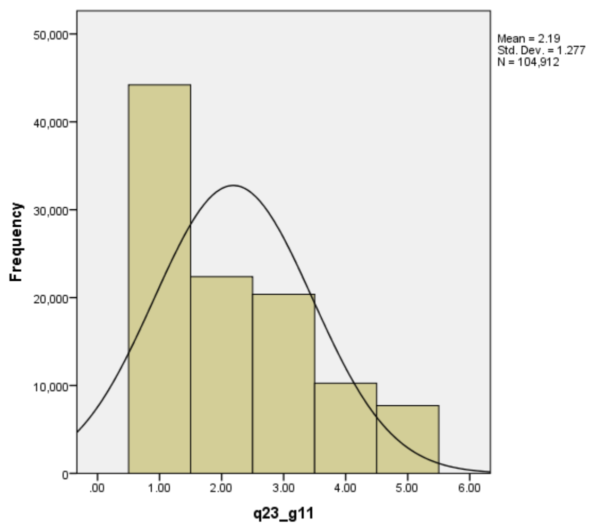

Figure 8. Normality of the frequency of students using online writing tools to improve their writing

This histogram depiction of the data identifies that the distribution is skewed positively to the right. This indicates that this self-directed digital learning behavior (using online writing tools) is a relatively infrequent activity for this sample.

As evident by the means noted in Table 4, and the histograms for each learning behavior, the frequency of students' participation in these self-directed, digital learning behaviors varies. Students' researching of a website represents a normal distribution with a symmetrical distribution of students' exhibiting that behavior as not. Watching a video to learn how to do something is a behavior done more frequently by this sample than would be expected in a normal distribution. Less frequent behaviors include posting a question on a discussion board, finding experts online to answer questions, using writing tools to improve writing and tapping into social media to both identify people with like interests and to learn what others are thinking or doing around an interest topic. While playing an online game or virtual simulation activity is nominally not perfectly symmetrical in the distribution, it is approximating that type of a distribution due to the high percentage of students indicating that they sometimes exhibit that behavior. Additionally, it should be noted that none of the learning behaviors are devoid of participants at any of the regularity or frequency levels of participation, from never to all of the time. While this data can provide education leaders with new insights into the frequency of these types of self-directed learning behaviors by middle school students, the data also opens up more questions for analysis.

The discussion about the frequencies of students using social media tools to self-direct learning foreshadows an exploration of relationships between the self-directed digital learning behaviors, and specifically, the strength and direction of those relationships. This exploration will investigate if there are positive correlations between the behaviors.

To explore the relationships between the self-directed, digital learning behaviors, a correlation analysis was conducted using a Pearson product-moment correlation coefficient process. Analysis of the strength of the relationship follows the interpretation guidelines espoused by Cohen (1988, pp. 79-81). Cohen uses a scale of small ($r = .10$ *to .29*), medium ($r = .30$ *to .49*) and large ($r = .50$ *to 1.0*), where r is the Pearson correlation coefficient.

The statistical tests reveal that a positive correlation exists between all of the learning behavior variables with varying levels of strength noted between certain behaviors. The strongest strength of relationship is with the two social media oriented learning behaviors (LB #4 and LB #5) indicating a large correlation in those activities (r = .764). A review of the shared variance between these two learning behaviors reinforces that correlation (shared variance of 58%). Moderate strength relationships existed for the majority of the self-directed learning behaviors (r = .30 to .49) including the following:

- LB #1 (websites)
    - LB #2 (video); r = .441
    - LB #6 (experts); r = .322
    - LB #8 (writing tools); r = .343
- LB #2 (videos)
    - LB #4 (social media); r = .329
    - LB #5 (social media); r = .351
    - LB #7 (games); r = .376
- LB #3 (questions)
    - LB #4 (social media); r = .451
    - LB #5 (social media); r = .429
    - LB #6 (experts); r = .469
    - LB #7 (games); r = .308
    - LB #8 (writing tools); r = .425
- LB #4 (social media – identifying people)
    - LB #6 (experts); r = .433

    - LB #7 (games); *r* = .433
    - LB #8 (writing tools); *r* = 328
- LB #5 (social media – learning what people are thinking or doing)
    - LB #7 (games); *r* = .329
    - LB #8 (writing tools); *r* = .339
- LB #6 (experts)
    - LB #7 (games); *r* = .353
    - LB #8 (writing tools); *r* = .412
- LB #7 (games)

  LB #8 (writing tools); *r* = .374

Small strength relationships were evident in relationships between five learning behaviors; LB #1 and LB #4 - website and social media (*r* = .254), LB #1 and LB #5 - website and social media #2 (*r* = .288), LB #1 and LB #7 - website and game play (*r* = .278), LB #2 and LB #3 - video and question posting (*r* = .257) and LB #2 and LB #8 - video and using writing tools (*r* = .283). The shared variance or coefficient of determination calculations underscores the lack of a strong relationship between these noted behaviors. For example, the shared variance of researching a website and using social media to identify people is only 6%. It should be noted however that with large samples such as used in this study even small correlations (e.g., *r* = .2) can have statistical significance as noted in Table 13, Sig. (2-tailed) statistics.

What is the significance of student characteristics on self-directed learning?

Additional items on the Speak Up survey provide an opportunity to learn more about the types of students that are exhibiting self-directed digital learning behaviors and to examine if any statistically significant differences exist based upon student characteristics (gender, self-assessment of technology skills, interest in a STEM field) or assets (access to the Internet at home). The key additional items that are relevant to this study are the following:

- What is your gender? (girl, boy)
- What kind of Internet access do you have at home? (fast connection, slow or no connection)
- How would you rate your technology skills compared to other students in your class? (advanced, average combined with beginner)
- Are you interested in a job or career in a STEM field? (Likert scale of interest)

Using an independent sample t-test I compared the mean scores on the continuous variable of each specific self-directed digital learning behavior for each of the two groups of participants determined by the four questions. For example, means were compared for girls and boys. Additional means comparisons were conducted using students who reported having a fast Internet connection at home and students who did not, students who assessed their technology skills as advanced and those that did not, and students with an interest in a STEM career field and those that did not have that same level of interest. The comparison identifies whether there is a statistically significant difference in the mean scores for the two tested groups. While these calculations can be interesting, they fail to explain if the two variables are associated with one another by chance or as a result of an intervention or variable; thus it is important to further test the strength of the association, or the effect size. It is also advisable in research using large samples such as with this study that effect sizes be calculated since even small or trivial effects can produce statistically significant results in large samples. I used a *Cohen's d* calculation to determine the effect size for all group comparisons. The *Cohen's d* calculation which measures the strength or magnitude of the difference in standard deviation units is reported using a scale of .2 standard deviation units as a small effect, .5 as a medium effect and .8 as a large effect.

The group statistics, independent sample t-tests and effect size calculations are reported for each of the comparative groups followed by an interpretation of the results. As noted the complete descriptive statistics are provided in Appendix C.

Significance of gender on self-directed digital learning behaviors. An independent samples t-test was conducted to compare the self-directed, digital learning behaviors for middle school girls and boys. There was a statistically significant difference in scores for girls and boys across all eight (8) self-directed digital learning behaviors. For example, when examining the self-directed behavior of researching a website, there was a significant difference in scores for girls (M = 2.958, SD = 1.106) and boys (M = 2.872, SD = 1.136; t (107422) = 12.653, p = .000, two-tailed). Effect size testing was conducted to measure the strength of the differences using a *Cohen's d* calculator. As all of the d calculations were .2 standard deviation units or less, the effect sizes are considered small for all of the self-directed digital learning behaviors based upon gender as a variable.

Significance of access to high-speed Internet access outside of school on self-directed digital learning behaviors. Two groups were formed from the study data to explore the significance of home Internet access on the self-directed digital learning behaviors. In one group students reported having fast or high speed Internet connectivity at home; in the other group, students reporting having no Internet access or that their at home Internet access was slow such as with dialup connectivity.

An independent samples t-test was conducted to compare the self-directed, digital learning behaviors for middle school students with varying levels of internet access at home; one group reported high speed internet connectivity; the other group did not. There was a statistically significant difference in scores across all eight (8) self-directed digital learning behaviors. The use of social media to learn what others are doing and thinking about a topic of interest was almost insignificant between the two groups, students with high speed internet access ($M = 2.161, SD = 1.309$) and the students without that access ($M = 2.128, SD = 1.288; t(13356) = 2.042, p = .041$, two-tailed). Effect size testing was conducted to measure the strength of the differences using a *Cohen's d* calculator. As all of the *d* calculations were less than the .2 standard deviation units the effect size is deemed as small when considering the significance of home Internet access on self-directed learning behaviors.

Significance of students' self-assessment of their technology skills on self-directed digital learning behaviors. With these statistical tests, two new groups were formed from the study data to explore the significance of a student's self-assessment of their technology skills on the self-directed digital learning behaviors. In one group students categorized their technology skills as advanced compared to their peers; the other group included students who ranked their skills as average or beginner level.

An independent samples t-test was conducted to compare the self-directed, digital learning behaviors for middle school students who assessed their technology skills as advanced or average/beginner. There was a statistically significant difference in scores across all eight (8) self-directed digital learning behaviors. For example, when examining the self-directed behavior of researching a website (LB #1), there was a significant difference in scores for the technology advanced students (*M = 3.0887, SD = 1.174*) and the technology average/beginner students (*M = 2.849, SD = 1.094; t (50347) = 30.408, p = .000,* two-tailed). Effect size testing was conducted to measure the strength of the differences using a *Cohen's d* calculator. The standard deviation units ranged from .14 for the use of online writing tools (LB #8) to .33 for playing an online game (LB #7). For purposes of this study, I am considering all of these effect sizes to be small but will note the differences between the various learning behaviors and discuss the implications of those differences in the next chapter.

Significance of students' interest level in a STEM career field on self-directed digital learning behaviors. To evaluate whether a statistically significant difference exists in the self-directed learning behaviors based upon students' interest in STEM fields, two groups were formed from the study data. In one group students indicated being very interested or somewhat interested in a STEM career field; the other group included students who said they were not interested or had no opinion.

An independent samples t-test was conducted to compare the self-directed, digital learning behaviors of two groups of middle school students; those that indicated interest in a STEM career field, and those that said they were not interested in a STEM career field. Statistically significant differences in scores exist for seven of the eight self-directed digital learning behaviors. Statistical significance is not evident for the use of social media to learn about what others are thinking or doing on a particular interest topic

(LB #5) for both groups; the students with STEM interests ($M = 2.282, SD = 1.351$) and the students without STEM interests ($M = 2.291, SD = 1.341; t(78887) = -.984; p = .325$, two-tailed). Effect size testing was conducted to measure the strength of the differences using a *Cohen's d* calculator. All of these effect sizes are considered small with exceptional smallness noted for both of the social media oriented learning behaviors (LB #4 and LB #5).

In summary, the statistical testing to determine the significance of student characteristics on self-directed digital learning behaviors indicates an provocative finding. While statistical significance is evident when comparing gender, home Internet access, technology skill self-assessment and interest in STEM fields, the effect size or magnitude of that significance within the self-directed digital learning behaviors is overall only of a small size. Further discussion of the implications of that finding will be discussed in the following chapter.

Are there relationships between self-directed learning and learning attitudes?

To further understand the lived experiences of middle school students using digital tools, content and resources to self-direct learning, I conducted a correlation analysis to explore the direction and strength of any relationships between students' stated values around learning and their out of school digital learning behaviors. A Speak Up survey item asked students to indicate their agreement with various general statements about learning. Four particular statements from that item were identified for examination. The four identified statements were:

- I like learning how to do things
- I like learning about new ideas

- I am learning important things for my future on my own outside of school
- I like learning when I am in control of when and how I learn

In addition to providing new insights about students' perceptions on learning, these particular statements align with the study's working hypothesis about the free agent learner who is self-directed learning using digital tools outside of school. Three of the statements represent key tenets of self-determination theory (Ryan & Deci, 2000). "I like learning how to do things" represents competence. "I like learning about new ideas" signifies the importance of relatedness. "I like learning when I am in control of when and how I learn" indicates a strong preference for autonomy. Additionally, agreement with the statement, "I am learning important things for my future on my own outside of school" is a strong indicator of the value associated with the purposeful, self-directed learning skills that Wagner believes are essential to prepare today's students for success in the global economy and society (2012).

Students responded to these statements by choosing a level of agreement using a five part Likert scale (strongly disagree, disagree, neither agree nor disagree, agree and strongly agree). The statistics scaled as 1 = strongly disagree and 5 = strongly agree.

A positive correlation exists between each of the self-directed digital learning behaviors and the attitude statements about learning. It should be expected therefore that as the learning behavior frequency increases, the agreement with the learning attitudes will increase as well. Using Cohen's scale, all of the relationships are considered small in strength. Comparatively, the strongest relationships are associated with two specific learning behaviors, and two of the learning attitude statements. Researching a website (LB #1) is positively correlated with "I like learning to do things" (r = 257) and " I like learning new ideas" (*r* = .279). Watching a video (LB #2) is positively correlated with "I like learning to do things" (*r* = 249) and " I like learning new ideas" (*r* = .236).

Do self-directed digital learning behaviors support SDT?

Self-determination theory (SDT) provides a construct within this study to understand that role of intrinsic motivations within students' use of digital tools, content and resources to support self-directed, interest driven learning. Ryan and Deci (2008) theorize that intrinsic goals are directly linked to the satisfaction of three basic psychological needs; autonomy, competence and relatedness. To explore the hypothesis that students' self-directed digital learning supports the satisfaction of these three basic needs, I examined the strength, direction and effect sizes of relationships between the learning behaviors and students' valuations on the impact of technology on their learning outcomes and skill development. The valuations selected for this analysis represent proxy statements for how technology used for learning supports the three basic psychological needs of SDT; autonomy, competence and relatedness.

On the Speak Up survey, middle school students were directed to choose responses that best represented their valuation of the impact of technology as a completion phrase to this sentence: "As a result of using technology to support my learning,…" From that response items, I selected the following statements as the best representations of the SDT tenets.

- Autonomy:
    - I am able to learn at my own pace
    - I have more control over my learning
- Competence:

  - I am developing critical thinking and problem solving skills
  - I am developing creativity skills
  - I spend more time mastering a skill or learning something
- Relatedness:
  - I work together with my classmates more often
  - I participate more in class discussions

The distribution of the frequencies of the students' selection of these various attitude statements about the impact of technology on their learning outcomes is illustrated in table 6. It should be noted that differences in students' access to or use of technology within their school environment was not evaluated as part of this study but would be a worthy follow-on research topic.

Table 6. Distribution of participants' responses about the outcomes of the use of technology within learning

Frequency of participation	Responses		Percent of Cases
	N	Percent	
I am able to learn at my own pace	67738	14.7%	65.2%
I have more control over my learning	60526	13.1%	58.3%
I am developing critical thinking and problem solving skills	55618	12.0%	53.5%
I am developing creativity skills	65693	14.2%	63.2%
I spend more time mastering a skill or learning something	53836	11.6%	51.8%
I work together with my classmates more often	65870	14.2%	63.4%

Table 6 Continued

Frequency of participation	Responses		Percent of Cases
	N	Percent	
I participate more in class discussions	53140	11.5%	51.2%
Total	422421	100.0%	406.60%

To explore whether a relationship exists between students' valuations of using technology for learning (outcome values) and their self-directed digital learning behaviors I conducted a means comparison using an independent samples t-test to evaluate the direction and strength of any relationship. Additionally, as has been the standard practice in this study, I calculated the effect size using the Cohen's *d* calculations for each learning behavior relative to the outcome values.

Each of the right learning behaviors and learning outcomes were evaluated individually. The finding for each comparison was consistent across all of the behaviors. As an illustration, the results from the testing with the learning outcome, "I work together with my classmates more often," is provided here.

An independent samples t-test was conducted to compare the self-directed, digital learning behaviors for students who value technology for its collaborative outcome ("I work together with my classmates more"), and those that do not. There was statistical significance across all eight behaviors for the students who valued technology for its collaborative outcome. For example, when examining the self-directed behavior of using social media to identify people who share interests (LB #4), there was a significant difference in scores for students who attributed the value of technology use to fostering greater collaborations (M = 2.3300, SD = .00555) and students who did not choose that response (*M* = 2.0247, *SD* = .00609; *t* (99253.525) = 37.03, *p* = .000, two-tailed). Effect size testing was conducted to measure the strength of the differences using a *Cohen's d* calculator. All of these effect sizes are considered small.

As noted earlier, group statistics, means comparisons and effect size calculations followed a similar pattern for each of the technology learning outcomes statements and self-directed learning behaviors. Statistical significance was evident in each test comparing students that had chosen the particular outcome statement (an indication of agreement with that statement) and those that did not. Effect sizes across the spectrum of the responses were small.

An additional interesting pattern however emerged from a closer examination of the effect sizes that supports an earlier analytical result and the hypothesis about the relationship between self-directed digital learning and SDT. In my analysis of the strength and direction of the relationships between the various self-directed digital learning behaviors, I noted that the majority of those relationships were medium in strength, with only one pair having a large relationship strength. That statistical result is further supported in the analysis of which learning behaviors had the highest effect sizes when examined in relation to the learning outcome statements. For example, the highest effect sizes calculated for the learning outcome statement, "I work together with my classmates more," was for the self-directed learning behaviors of watching a video (.23), using social media to identify people (.23), using social media to learn what others are doing or thinking (.24), finding experts online (.2) and playing an online game (.22). The correlation analysis indicated a medium to large strength of relationship between each of these particular self-directed learning behaviors. A similar pattern exists for the other learning attitude that supports relatedness, “I am participating more in class discussions.” Within the three learning outcome statements that support competence, the highest effect sizes are for self-directed learning behaviors that have a moderate strength relationship. For both statements that support autonomy, the highest effect size is for playing an online game and watching a video, both with moderate strength relationships. Though the effect sizes of all of the statistical significance of the means comparison is small per the Cohen’s *d* calculation, it is interesting that the strength of the relationships between the learning behaviors followed a consistent pattern that followed the SDT groupings of the learning attitude statements. The implications of the relationship between students’ attitudes on the learning outcomes from technology use and their self-directed digital learning behaviors is further discussed in the next chapter.

Phase II Results

The goal of the Phase II data analysis was to examine the motivations or purposes behind students’ self-directed learning activities. To achieve this goal, two different analytical approaches were leveraged. First, the relationships between the self-directed digital learning behaviors were re-examined with a new lens. To better understand students’ motivations or purposes for using digital tools for self-directed learning, a survey item asking students’ their preferences for exploring careers was used as a proxy for purposeful learning. One sub-cohort represented students who chose digital or online tools and resources for career exploration activities. The second sub-cohort chose traditional means as their preference for career exploration. Data from the two sub-cohorts of students was used to understand if differences exist in the learning behavior relationships based upon if the students wanted to use digital tools or traditional means for career exploration.

Second, the open-ended narrative responses from a selected set of middle school students were analyzed to determine what digital tools the students say they are using to self-direct their learning, and the purposes that they ascribe to that usage. Two separate analytical strategies were used to accomplish these tasks. First a summative content analysis was completed to identify the tools used by the students based upon what was learned through the analytics of Phase I. Then a constructivist grounded theory approach was utilized to structure the analysis of the narrative responses with an intent to reveal the purposes behind the students' learning behaviors. Included in the analysis was a consideration of any differences in students' articulation of their self-directed learning behavior based upon if their school was located in an urban, rural/town or suburb community.

The reporting of the quantitative and qualitative data results derived from the Phase II analysis is therefore organized around these three key questions:

1. How do students' aspirations for using digital tools to explore careers influence the strength and direction of the relationships between the self-directed digital learning behaviors? A correlation analysis was used to determine the strength and direction of the relationship between the digital learning behaviors for the two sub-cohorts.
2. What digital tools are middle school students using to self-direct learning outside of school around areas of interest? On the Speak Up survey, the students were asked to respond narratively to this open-ended prompt, *"Some*

students are using social media tools, videos and online games outside of school to explore or teach themselves about academic or school topics that interest them. How are you using technology outside of school to learn new things or skills? What are you learning about? What digital tools or resources are you using?" Using results from the Phase I analysis, a summative content analysis approach was first applied to the responses from 3,253 students to identify four categories of digital tools as vehicles for self-directed learning; games, videos, websites, and social media. The selection of these four tools as a coding mechanism was indicated by our Phase I analysis. Three of the four tools approximated a normal distribution (Figures 1, 2 and 7). The fourth tool, social media, includes two separate learning behaviors, using social media to identify people and using social media to learn what others are doing and thinking. The large strength of the relationship and the high shared variance between the two social media oriented behaviors was a noteworthy result of the statistical testing in Phase I. Thus, it was deemed interesting to explore the extent in which the students identified social media as a tool for self-directed learning. The frequency of the use of the names of these tools, or their proxy names, as they appeared in the students' responses was calculated. Examples of the students' descriptions of their tool use are included in this section.

What do the students say are the motivations or purposes behind these self-directed learning activities? Using the same qualitative data set from the question above about the tools used, I employed a constructivist grounded theory approach, an interpretational technique, to reveal a wide range of purposes for students' self-directed digital learning. That set of potential motivations was distilled down to four primary or driving purposes. Included in this analysis is an examination of whether the students' motivations or purposes differ by type of community, i.e., urban, rural/town or suburb. Examples of the students' stated purposes for their self-directed learning is included in this section.

Do students' digital aspirations influence the learning behavior relationships?

In his landmark work about how schools need to change to address the needs of students today, Wagner puts a strong emphasis on the criticality of students developing specific skills to be successful in the global, information-intensive society (2012). Reminiscent of the results from Ito's (2010) studies, Wagner points out that students want to learn these skills through connections to others, self-directed discoveries and through the creation of content to showcase their knowledge and skills. This sentiment is echoed by the data results derived from a particular item on the Speak Up survey.

Middle school students were asked on the survey to identify the ways that they would like to explore future careers or be prepared for a future job. The response items included digital and online vehicles for that career exploration as well as traditional approaches. The digital and online items used to support career exploration preferences included:

- Learn about careers through social media
- Play an online or video game to learn more about a career
- Learn about different jobs through "Day in the Life" videos

- Use mobile apps or websites to explore careers

The traditional career exploration vehicles included these options:

- Go to an after school program
- Go on field trips to companies and meet successful people
- Learn from teachers that have worked in that type of job
- Let career professionals teach lessons at school
- Take a quiz to find out my career interests or strengths
- Participate in science and math competitions
- Work with mentors who can help me with planning my future
- Go to a summer camp (like space camp)
- Use technology tools to make things (like 3D printers and maker software)

The distribution of student responses to this item is reported in Table 7.

Table 7. Distribution of participants' responses about the ways they would like to explore careers

Frequency of participation	Responses		Percent of Cases
	N	Percent	
Go to an after school program	39959	6.0%	33.6%
Go on field trips to companies and meet successful people	82355	12.4%	69.2%
Learn about careers through social media like Twitter and Facebook	34204	5.2%	28.7%
Let career professionals teach lessons at school	68795	10.4%	57.8%

Table 7. Continued

Frequency of participation	Responses		Percent of Cases
	N	Percent	
Learn from teachers that have worked in that type of job	59096	8.9%	49.6%
Play an online or video game to learn more about a career	47696	7.2%	40.1%
Take a quiz to find out my career interests or strengths	67121	10.1%	56.4%
Learn about different jobs through "Day in the Life" videos	43068	6.5%	36.2%
Use mobile apps or websites to explore careers	59337	8.9%	49.8%
Participate in science and math competitions	25837	3.9%	21.7%
Work with mentors who can help me with planning my future	49654	7.5%	41.7%
Work with mentors who can help me with planning my future	49654	7.5%	41.7%
Use technology tools to make things (like 3D printers and maker software)	50203	7.6%	42.2%
Total	663771	100%	557.4%

To address my question about how students' digital aspirations for career exploration (a proxy for a purposeful activity) may influence the relationships between the self-directed digital learning behaviors undertaken by the students, I divided the middle school students' responses into two sub-cohorts. One cohort (identified as Cohort

A) included the students who exclusively chose all four of the digital and online career exploration methodologies (N = 10,974). Cohort B was comprised of the students who chose a variety of traditional options (N = 108,104). A correlation analysis was run with data from each cohort to look at the strength and direction of the relationships between the self-directed learning behaviors for that specific cohort.

The relationships between the self-directed digital behaviors were investigated using Pearson product-moment correlation coefficient. For Cohort A students who want to use digital measures to explore careers, all of the self-directed digital learning behaviors showed a positive and moderate to strong correlation. The strongest relationship was between the social media oriented variables, using social media to identify people (SM #1) and using social media to learn what others are thinking and doing (SM #2), $r = .791$, $n = 9504$, $p = .000$ with high levels of correlation between the use of social media to identify people and the use of social media to learn about what people are thinking and doing around a particular interest topic. The relationships between the learning behaviors for this cohort are stronger than the general population.

The relationships between the self-directed digital behaviors were investigated using Pearson product-moment correlation coefficient. For Cohort B students who want to use traditional measures to explore careers, all of the self-directed digital learning behaviors showed a positive correlation with a range of strength within the behaviors from small to large. The strongest relationship was between the social media oriented variables, using social media to identify people (SM #1) and using social media to learn what others are thinking and doing (SM #2), $r = .754$, $n = 91903$, $p = .000$ with high levels of correlation between the use of social media to identify people and the use of social media to learn about what people are thinking and doing around a particular interest topic. This strong relationship between the social media variables mimics the affect noted for the general population of students and for the students in Cohort A noted above.

Additionally, the strength of the relationships between the learning behaviors of findings online experts to answer questions (experts), posting a question on a discussion board (question) and the two social media behaviors are closely aligned on both the Cohort A and Cohort B correlations. The calculation of the shared variances (the coefficients of determination) supports this result. For example, the shared variance between the variable of finding online experts and using social media to identify people is 24% for Cohort A and 17% for Cohort B. Similarly, the shared variance for posting a question on a discussion board and using social media to learn what others are thinking or doing is 21% for Cohort A and 17% for Cohort B. Comparatively, other shared variances show marked differences between Cohort A and Cohort B. For example, while there is a shared variance of 24% between playing an online game and watching a video within Cohort A, there is only a 6% variance within Cohort B.

This examination of the strength and direction of the relationships between the learning behaviors within the construct of students' preferences for career exploration modalities provides an entry point for the investigation of the purposes and motivations of students' self-directed learning in general.

What tools are students using to support their self-directed digital learning?

To investigate the purposes and motivations of student use of digital tools, content and resources to drive self-directed learning, I analyzed narrative responses from 3,253 middle school students representing a diverse set of schools and communities. On the Speak Up survey, students were given an opportunity to write a narrative response to this question prompt:

> *Some students are using social media tools, videos and online games outside of school to explore or teach themselves about academic or school topics that interest them. How are you using technology outside of school to learn new things or skills? What are you learning about? What digital tools or resources are you using?*

Student responses took the form of one to two sentences or short paragraphs. Using those narrative responses as the basis for this analysis, the specific intent of the qualitative investigation was two-fold. The first goal of this analytical process was to quantify the use of various digital tools as mechanisms for self-directed learning as articulated by the students. The second goal was to gain a new understanding about why students are self-directing learning using these tools and through that understanding to identify the primary purposes behind the free agent learning process.

To first gain an understanding of the extent of the self-directed digital learning behaviors in each school, the frequencies for each behavior was calculated, and compared to the national data sample by NCES locale codes. For this particular analysis, the comparative data is based upon the percentage of students who chose the frequency responses of "all of the time" plus "often." Table 8, 9 and 10 provide the comparative data analysis for the urban, suburb, and rural/town schools respectively.

Table 8. Distribution of frequent self-directed, digital learning behaviors for the study schools in urban communities

Learning Behavior	Urban – National N = 35166	Urban – School A N = 758	Urban – School B N = 478
LB #1	31.0	30.8	36.8
LB #2	44.9	48.4	41.3
LB #3	9.6	5.7	10.4
LB #4	18.4	19.5	15.9
LB #5	19.3	21.8	18.4
LB #6	14.1	10.9	15.5
LB #7	29.0	25.1	26.2
LB #8	19.0	14.4	20.1

Table 9. Distribution of frequent self-directed, digital learning behaviors for the study schools in suburb communities

Learning Behavior	Suburb - National N = 46420	Suburb – School C N = 472	Suburb – School D N = 811
LB #1	28.2	27.5	26.0
LB #2	44.6	50.8	40.2
LB #3	8.9	12.1	19.4
LB #4	20.7	30.4	21.2
LB #5	21.8	29.5	19.4
LB #6	14.0	18.6	19.5
LB #7	29.1	39.7	23.6
LB #8	16.5	18.8	17.4

Table 10. Distribution of frequent self-directed, digital learning behaviors for the study schools in rural/town communities

Learning Behavior	Rural - National N = 46224	Rural – School E N = 502	Rural – School F N = 792
LB #1	28.3	28.5	36.5
LB #2	43.7	46.4	45.1
LB #3	9.1	8.2	19.9
LB #4	19.4	22.4	23.7
LB #5	20.2	24.0	25.6
LB #6	13.1	13.1	14.6
LB #7	29.0	30.2	35.1
LB #8	16.1	17.7	19.8

The comparative analysis of the percentage of students who are self-directing learning at the frequency level of all of the time plus often reveals a certain degree of variance in certain learning behaviors and within certain schools. For example, more students in School C appear to be watching videos, accessing social media and playing online games to self-direct learning than their peers in School D. Consequently, the further analysis of the tools used within the self-directed learning and the purposes behind those behaviors includes an analysis at the school level of the students' narrative responses to potentially explain some of these differences.

To identify the tools used to support students' self-directed learning in the six study schools, I used a summative content analysis strategy that leverages what was learned in the Phase I analysis of this study. With that analysis strategy, codes are pre-determined and the qualitative data is mined for those particular codes. In the Phase I analysis I learned that the tools that most closely approximately a normal distribution pattern for usage was researching a website (LB #1), watching a video (LB #2) and playing an online game (LB #7). Those three tools were thus chosen as the markers or codes for analyzing the narrative responses from the students. Additionally, given the strong correlation between the social media oriented learning behaviors (LB #4 and LB #5), I included social media as a code for analysis as well since it may represent an emergent area for future research. Each of the 3,253 written responses from the middle school students at the six study schools was read and hand coded based upon the digital tool that the student said they used to self-direct their learning. The first level coding schema was as follows.

- Tool = website
- Tool = video
- Tool = game

- Tool = social media
- Not applicable response

Responses were coded as not applicable for three reasons, (1) the student response was focused on the use of technology within the school day or in service of doing homework or other teacher-assigned activities, (2) the student did not indicate both a tool and a purpose for their self-directed learning behavior, and (3) the response was illegible or incomplete. The responses deemed as not applicable were subsequently excluded from further analysis.

The coding of the digital tool was interpretational based upon my prior knowledge and experience in this field. For example, many students identified “Minecraft” as the tool that they used to self-direct their learning. Minecraft is an educational game and thus those responses were coded as games. Similarly, many students noted that they regularly use YouTube or Kahn Academy for their self-directed learning activities. Both YouTube and Kahn Academy provide access to videos; those responses were therefore coded as videos. Student responses that mentioned popular online brand names such as Twitter, Instagram or Pinterest were coded as social media; Google references was coded as web-based activities.

The narrative responses from students at each school were coded individually and categorized based upon the NCES locale code for each school. Table 11 reports the distribution of the tools identified by the students at the six study schools. The table also documents the total number of narrative responses per school and the percentage of responses calculated as qualified for analysis and coded as not applicable.

Table 11. Distribution of digital tools used by students for self-directed learning by study school

School	Total responses	Qualified responses	Not applicable	Tool = Game	Tool = Social Media	Tool = Video	Tool = Web sites
School A (urban)	317	82	235	18%	7%	24%	51%
School B (urban)	703	330	373	20%	7%	52%	38%
School C (suburb)	805	241	564	20%	9%	35%	48%
School D (suburb)	349	110	239	13%	10%	35%	55%
School E (rural)	676	216	460	24%	11%	38%	47%
School F (rural)	403	198	205	12%	12%	35%	57%
Totals	3,253	1,177	2,076				

Similar to the differences noted at the school level in terms of the frequency of the self-directed learning behaviors, the use of the four identified digital tools also indicates some variations student tool usage by school. However, the general trend line is consistent with prior analytical results. Students identified their most popular self-directed learning behaviors as researching a website (LB #1) and watching a video (LB #2). Correspondingly, the most frequently noted tools within the narrative responses echo that finding. Across all six schools, websites and videos were the most frequently noted within the responses regardless of school demographics or community type.

Similar to the differences noted at the school level in terms of the frequency of the self-directed learning behaviors, the use of the four identified digital tools also indicates some variations student tool usage by school. However, the general trend line is consistent with prior analytical results. Students identified their most popular self-

directed learning behaviors as researching a website (LB #1) and watching a video (LB #2).

What purposes or motivations drive students' self-directed digital learning?

The identification of the purposes or motivations driving students' self-directed digital learning required a more organic approach to the coding analysis. Unlike with the coding for the tools, I did not begin the coding process with any particular constructs from the earlier quantitative analysis to use as guideposts in the analysis. Rather, I followed the constructivist grounded theory analytical approach popularized by Charmaz (2012). Key components of this approach include a focus on inductive inquiry, close coding of narratives and an orientation that allows explanations of behaviors and processes to emerge from the studied data (Charmaz, 2012; Mills, Bonner & Francis, 2006; Creswell, 2013). Central to the constructivist model for grounded theory is answering the question why, but also key is providing conclusions more as suggestions for further refinement as the field of study continues to advance. A significant difference between traditional grounded theory analytics and the constructivist model is the role and positioning of the researcher (Mills). The constructivist approach embraces the positionality or prior background that the researcher brings to the analysis while the traditional approach mandates that the researcher approach the data with a blank slate. Given my background in this field, it is reasonable to expect that I would leverage those experiences in the analysis, especially as it pertains to reviewing the narrative student responses. My valuing of my positionality as an asset, not a liability was discussed in Chapter One. Overall, the constructivist grounded theory approach aligned well with the emergent state of the research in this field and my goals for understanding the purposes behind students' self-directed digital learning.

As noted earlier, to be included in the analysis, student responses needed to identify both a tool and some description of how that tool was used in a learning process. Of the 3,253 student responses originating from the six study schools, 1,177 met this criteria. The 1,177 responses were therefore analyzed using the constructivist model.

Coding of the student responses was an iterative process focusing less on categories in the beginning and more on processes, actions and meanings behind the behaviors. The identification of gerund based phases from the review of the student responses helped to clarify the four major categories of purposes or motivations driving students' self-directed learning behaviors at the six study schools. Table 12 summarizes how a sampling of gerund phrases derived from the coding process translated into the four purpose categories.

Table 12. Sampling of coding results from analysis of students' narrative responses

Gerund phases derived from the students' responses	Primary purposes driving students' self-directed digital learning
○ Watching a video to learn how to do a math problem ○ Searching for websites to understand what was taught in school ○ Asking for help on social media ○ Playing Study Island to practice concepts to improve grades ○ Needing a different way to learn or understand class materials ○ Googling for math videos or tutorials	Self-remediation
○ Playing games to learn about how to handle money ○ Posting my writing on online story sharing sites to get criticism ○ Learning how to play the guitar by watching YouTube videos	Skill development

Table 12. Continued

Gerund phases derived from the students' responses	Primary purposes driving students' self-directed digital learning
○ Teaching myself French by using Google translate ○ Watching drawing videos because I like to draw ○ Going to Kahn Academy to learn how to code	
Gerund phases derived from the students' responses	Primary purposes driving students' self-directed digital learning
○ Using Instagram to learn what other people think about topics I am interested in ○ Watching videos to learn about scientific and technological advances in the world ○ Researching online about things that I want to learn more about ○ Learning about chemistry by watching YouTube videos ○ Teaching myself by reading papers online, watching videos, going on free online textbooks and having online discussions	Curiosity
○ Using YouTube and other websites to learn about careers I am interested in ○ Researching what it takes to get accepted to Stanford ○ Preparing for my future by researching what it takes to pass the firefighter or police test ○ Using engineering software on my laptop because I am interested in being an engineer ○ Getting inspired by reading what fellow writers write about on Pinterest	Career Preparation

As demonstrated by the results in Table 12, the process of moving from gerund phases that emerged from the coding process to the identification of the categories of purpose was a highly interpretational activity that required making meaning from both the context of the response as well as the comparative analysis between the phrases. Emerging from the data analysis are the four primary categories of purpose are (1) self-remediation, (2) skill development, (3) curiosity and (4) career preparation. Table 13 provides a breakdown of the four purposes identified by the students in their responses by school.

Table 13. Distribution of student-identified purposes for self-directed learning by school

School	Total responses	Qualified responses	Not applicable	Purpose #1	Purpose #2	Purpose #3	Purpose #4
School A (urban)	317	82	235	48%	24%	27%	7%
School B (urban)	703	330	373	62%	20%	12%	2%
School C (suburb)	805	241	564	41%	23%	30%	7%
School D (suburb)	349	110	239	61%	13%	22%	5%
School E (rural)	676	216	460	53%	21%	34%	6%
School F (rural)	403	198	205	67%	11%	21%	7%
Totals	3,253	1,177	2,076				

The following explanations of the four primary purposes identified include quotes from the student responses that illustrate the defining characteristic of their stated purpose for the self-directed learning behavior.

Self-remediation. *"When I am confused on something we did in math I usually use youtube to search a video on how to solve that math problem, which actually really helps."* (8^{th} grade girl, School F).

The self-remediation category represents students' attempts outside of school to address what they perceived as weaknesses or deficiencies in what or how they are learning in school. The types of activities included within this category of self-remediation included specific references to needs for greater competence where students felt either a lack of understanding or a need to be taught in a different manner than their school experiences. For example, student responses frequently referenced a need to improve their math knowledge or skills, a need to improve their grades in math, and a need to experience a different teaching and learning modality to gain greater competence, again quite often in math specifically. In all cases, the responses indicated a self-directed approach to gaining this greater competence, thus the label of self-remediation for this category. While the students described using a variety of digital tools to support this self-remediation, the most frequently noted tools were videos and websites, quite often in combination with each other. As demonstrated in Table 13. the self-remediation purpose was the highest-ranking purpose or motivation reported by the students in all six study schools based upon the quantitative analysis of the coded responses on purpose. The following examples illustrate how the students are both articulating the need for competence and addressing it through self-directed, self-remediating approaches that leverage the identified digital tools.

> *"I often use khan academy when I don't understand my algebra 1-2 class. Doing the questions instead of just writing notes verbatim helps me in ways that a traditional classroom could not." (7th grade girl, School A)*

> *"I use YouTube to see how stuff is done such as point slope form and distribution of property for fractions. I usually check like 5 videos to make sure the contents of that video is correct." (7th grade girl, School D)*

> *"Well, I often have troubles in my Spanish class so I used this app called, "Rosetta Stone" where you are being taught different other languages*

while having fun. This is an excellent app for me because I love having fun while learning something new." (7th grade boy, School C)

"When I am outside of school, I sometimes look up topics that I do not fully understand. By doing this, I can learn about this topic more than the teacher explained it making it easier to understand. For example, if my science teacher explained to us the difference between what a chemical and physical change was and I did not fully understand it, I could go online after school and research it." (7th grade girl, School A)

"I am learning outside of school using new web sites that could help me with math skills. Also I learned more about power point while messing around with it after school." (7th grade boy, School E)

"I am using Study Island to practice different concepts so when I am in math or english it is easy for me to understand the concept." (8th grade girl, School A)

"I use YouTube a lot to watch videos on how to do math because I am really struggling in that subject." (6th grade girl, School F)

"Our teachers teach us one way to solve things when there are lots of ways to do things but when we think outside the box our ideas are shut

down. I go online after school to help myself better understand how something because in school they did not help me understand it in a way that would better help me." (8th grade girl, School C)

Skill development. *"I play games and have learned to listen or do what the game tells me. I can also learn how to handle my money on a game I play called Farming-Simulator." (7th grade boy, School E)*

The skill development category includes ways that students are using digital tools to support the acquisition and refinement of a wide variety of proficiencies or competencies. The origin for these learning behaviors is different from the impetus for self-remediation. Whereas self-remediation starts with a need for improvement in some academic area, the starting place for skill development is with a personal interest or curiosity. The interest areas that drive the skill development learning behavior are not limited to academics but rather include sports, personal grooming and the development of skills that the students believe are important for them to acquire for their future success. Another key component of the skill development behaviors is a belief that the skill or aptitude cannot only be acquired outside of formal education, but that potentially that informal or unformal approach may be a better modality for that experience and that student. An additional differentiator for the skill development category is a focus on *learning to do something*, rather than *learning about ideas or concepts*. Students report using a variety of digital tools to enable their skill development. As was noted in the self-remediation activities, there is a heavy emphasis on the value of video to support self-directed learning activities for skill development as well. The following examples from the students' responses demonstrate how the students are tapping into digital tools to develop new skills and in many cases, the rationale as to why that skill development is important or valuable for them. More so than was evident with the student responses to support self-remediation, the students' perspectives on the skills they need to acquire provides new insights into the differences in the communities and the needs for skills within those communities.

> *"I use technology outside of school by playing games like Kerbal Space Program and Minecraft. Kerbal Space Program is like science, testing a change in your spaceship and seeing what the change did. Minecraft is like Math, you calculate how many of each block you need to build the structure you are planning to build, and in a survival situation, you problem solve." (8th grade girl, School A)*

> *"I just use things like, Instagram and Twitter and other popular apps to learn about things and I think the apps are actually teaching more important things for life than what I'm learning in school. They teach me the easiest ways to get jobs. The easiest ways to get money. How to act around people and, so on." (8th grade girl, School F)*

> *"I use YouTube to learn how to work on trucks. I use google to learn how to do stuff on our farm." (8th grade boy, School E)*

> *"I am learning to code outside of school because I have an interest in it and there are jobs for people who can code. I am using khan academy to*

learn coding and I'm using cs101 which is another online coding class." *(8th grade girl, School A)*

"Once I searched videos on how to serve over-head for volleyball. I used my smartphone, which had a poor signal, yet I learned what I needed to." (8th grade girl, School D)

"I learn German through video chat and language apps like duolingo." (8th grade girl, School C)

"I use YouTube to look of videos about topics that interest me. I also use online story sharing websites to write stories and books to share with other young authors and get criticism on them, also use forums to learn how to be a better writer." (7th grade boy, School A)

"I am learning how to play the guitar I know it's not educational for school but its something I've always wanted to do so thanks to the school for letting us use iPads. I can search what I need to search. Mostly they are videos on YouTube that teach me how to play guitar. Also sometimes I get curious about law and order so I search how that works and certain things like that. (7th grade girl, School B)

Curiosity. *"There is information all over the internet, even if no one realizes. Every day, and I mean EVERY, I go on things like Instagram and Tumblr. There is information about current events, facts, and more that you can learn. I learn more on social media then in school sometimes."* (8th grade girl, School F)

Pink (2009) provides the grounding for this category of purpose, curiosity. As previously discussed, Pink maintains that people are innately curious and often pursue interests and learning to satisfy that curiosity or to solve a problem. The middle school student responses substantiate that premise. The students' curiosities or interests in learning things that are beyond the scope of traditional schoolwork content is often precipitated by a range of different stimuli. In their responses, many of the students mentioned that the spark for their self-directed learning activity was a discussion in their classroom or a topic that being studied. The result is a desire to learn more, to explore that topic to a deeper level and to make connections between that new information and other aspects of their life, including their school life.

The ubiquitous connectivity of today's students to the Internet also means that their awareness of global situations and happenings is very high as well. Many students noted that their familiarity with current events led them to the pursuit of more information, and it made sense to use the same online tools that sparked that interest in the first place. The students again demonstrate a proclivity for using a wide range of digital tools to satiate their curiosities about the world around them and specific topics of interest. The role of social media tools is particularly noteworthy as presented a unique way for the students to learn about people's ideas, and how those ideas translate into ideas and actions. Videos and websites still figure predominantly in the landscape of self-directed interest for these purposeful actions, as was noted for the self-remediation and skill development activities. The analysis of the students' responses in this category however was distinctly different from the responses for self-remediation and skill development in one significant way. While the students' actions in those two categories seemed both purposeful and planned, many of the students' statements about self-directed learning in pursuit of curiosities has a distinctly more sporadic, spontaneous or impulsive in nature. As students increasingly have a connection to the world in the palm of their hand, the ability to act on a curiosity is more realistic today than ever before with a quick Google search or scan of a Twitter deck. The following examples of student responses include several different representations of how students are using digital tools to satisfy a curiosity or to pursue information in an area of high personal interest.

> *"I usually use Instagram to discover other people in the world that like and want to do the same things as me. I personally believe it is easier for people to express who they are and what they want n life through technology and pictures. I find it easier to use social media and videos to learn things." (8th grade boy, School A)*

> *"After I come back from school, I like to go on YouTube and watch Scishow, Vsauce, AsapSCIENCE, MinutePhysics, and TedED. I learn a variety of things that seem interesting to me, from why rain smells to what if the Earth was flat." 8th grade boy, School C)*

"Sometimes i watch videos about space and videos i see that are interesting. this one time i watched a video about supernovas and black holes." (6th grade boy, School F)

"I use technology outside of school to learn new things fairly often, and I learn something new at least once a week. I am learning about different things in science using Youtube." (7th grade boy, School A)

"technology helps me out of school when I am curious or want to know something. For example I like math so I use cool math to help me learn more." (7th grade girl, School D)

"I use stuff like google to look stuff up that i had questions about or just want to look up. I use youtube to watch videos about simple things that everyone wonders about daily." (8th grade girl, School F)

"The way I use technology to learn new things outside of school is that sometimes when I learn about a new person or thing, I like to learn about it. So sometimes during passing or after school I look up the person or thing and read a couple articles about it. The websites I usually use are old news stories or bios about the thing or person. For example, in social studies when I learned about the Marbury vs Madison trial, I was very

interested about it. And I ended up learning more about it.” (8th grade girl, School A)

“I sometimes go on Google and ask questions that have popped up in my head about what we learned in school that day or the day before.” (8th grade girl, School F)

“I use technology outside of school to learn new things or skills by researching something to know about it better. I go on a lot of websites circled around the topic that I want to learn more about and usually that topic leads me to another topic that I want to learn more about. (Example: learning about space led me to wanting to know more about a certain planet like Neptune.) I often like learning about new things or current/past events happening around the world and I like using Google to research more about this. I also just like reading from the news website.” (8th grade girl, School A)

“I'm very interested in chemistry and physics and instead of learning the same lesson that has been taught since the 90's, I've been teaching myself by reading papers I find online, watching videos, going on free online textbooks, and having online discussions.” (7th grade boy, School A)

Career preparation. *"I go to website called space.com and it teaches me the things that are going on in space and how it can affect earth because I want to be an astronomer when I grow up and I want to study space."* (6th grade girl, School C)

With this category of career preparation, the students connected their use of digital tools outside of school to specific goals that supported aspirations for their future. The various sub-categories that summarized to this general purpose included seeking information about career fields and specific jobs as well as a broad category around higher education. Students reported using digital tools to research colleges that met their specific interest areas and exploring admission requirements and financial information. Quantitatively based upon the coding of the student responses, this category was the smallest of the four purposes or motivations with less than 10% of the responses across all six schools coded as career preparation. The student responses however provide valuable insights for education leaders about how students are thinking about their future, and how they are using the digital tools available to them outside of school to explore their options after high school. New curriculum standards are placing a higher emphasis on supporting the development of college and career ready skills within the curriculum and classroom instructional practices. This new attention on defining and articulating the types of skills that students need for future success is not lost on the students. While the assumption would be that high school students are the likely age group to be exhibiting self-directed learning behaviors to support career preparation, it may be surprising to some education leaders that middle school students are actively pursuing the same types of activities already. As noted in some of the earlier student responses coded for self-remediation and skill development, the students' frustrations with what they perceive as the lack of relevancy in their education is often quoted as the basis for their own self-exploration of information. The following examples of student responses demonstrate the variety of tools that middle schools are using to self-direct learning for career preparation, and the variety of motivations that are driving those behaviors.

> *"I am using engineering software on my laptop. Also, since I want to be an engineer/ design cars or houses, I use Minecraft to design lots of things. This type of technology helps me out a lot." (8th grad boy, School F)*

> *"I want to be a writer so I use Pinterest for my creative writing. I also use google and I have a tablet so therefore I can access these things. If I had these things in school I could be more creative and be more inspired by fellow writers." (7th grade girl, School E)*

> *"Well I want to become a firefighter, police officer, be in the army, or be in the CIA/FBI....with a degree of being an E.M.T. I use technology outside of school to help prepare me for my future like going to medical school, and researching whats on the firefighter and police test, and all of the important things that take place to getting my job and getting me to the right college." (7th grade boy, School A)*

> *"I use my devices that I borrow at home like a laptop, kindle, or smartphone to look up my dream college, Stanford. I search what it takes*

to be accepted and what programs it has to offer, I also sometimes search what different jobs pay the best or what career would best fit me." (7th grade girl, School D)

"Sometimes I go on Google and search about my future job and what it takes to succeed in that career. Also, I look up colleges that have my profession that I want to major in." (8th grade girl, School F)

"i am learning about mechanics & engineering . i am using websites that help me understand the basics of building , fixing , & putting back together a car . i am also using toy cars , by taking them apart & putting them back together (while timing myself)." (8th grade girl, School F)

"I am learning by researching about what I want to do as a career, because in school, the math and science and english and history I am learning is in no way helping me as my career. I search online about horseback riding and horse trainers, and how they teach, because Algebra, and learning about World War 2 is not helping me learn about horseback riding. I think we should be able to take classes around what we want to do as a person, not what the district wants us to learn." (8th grade boy, School A)

The analysis of the students' narrative responses to an open-ended question on the Speak Up survey answered two essential research questions for this study. First, students are using a range of digital tools to satisfy their needs or desires for information or skill development. Within the set of digital tools in use, videos and Internet searches resulting in websites were the most frequently identified in the students' responses across all six schools in the study. The subsequent constructivist approach to the coding process of these same narrative responses ultimately identified four primary purposes or motivations driving self-directed digital learning outside of school; self-remediation, skill development, curiosity and career preparation. Evidence of all four types of purposes was present in the data from students at all six schools as well. The discussion chapter will explore the linkages between the identified purposes for the self-directed learning and the literature and theoretical framework that are the foundation for this study. In addition, the constructivist grounded theory approach undertaken with the students' narrative responses provides an opportunity explore potential suggestions to explain the purposes of self-directed digital learning.

Summary of Results

The primary research question driving the study was to identify the learning behaviors, characteristics and purposes of students who are using digital tools to pursue self-directed, interest-driven learning outside of school. To explore that primary question, the study examined the validity of a working hypothesis on the activities and values of the *free agent learner* derived from the literature and my previous research. The working hypothesis is as follows:

> *Students exhibit the characteristics and behaviors of free agent learners when they use digital tools, resources and content outside of school to self-direct learning around areas of academic passion or personal curiosity, and these activities align with the identifying characteristics of self-determination theory (autonomy, competence and relatedness) and demonstrate a purposeful reason for the self-directed actions.*

To test this hypothesis, the study conducted a secondary analysis of a large-scale data set using quantitative and qualitative data collected from students in grades 6, 7 and 8.

This chapter documented the results from the statistical tests on the quantitative data and the latent content analysis of the students' narrative responses to an open-ended question about their self-directed learning behaviors. A summary of the key findings from these analytical procedures include the following:

1. Amongst the self-directed learning behaviors, students' researching a website and watching a video represented or closely represented a normal distribution. While there was a positive correlation between all eight of the self-directed learning behaviors studied, the strongest relationship exists between the two social media oriented behaviors; using social media to identify people with similar interests and using social media to learn what others are doing or thinking about a topic of interest.
2. Differences based upon student characteristics (gender, technology skill self-assessment, interest in a STEM career) or assets (access to the Internet outside of school) were statistically significant for all self-directed learning behaviors except

for one. However, the effect size of those statistical differences between the various characteristics and the learning behaviors was small.

3. A positive but small correlation exists between students' attitudes about learning in general and their self-directed learning behaviors. Similarly, it was demonstrated that there was a statistical significance in students' perceptions on the value of technology within learning, measured as outcomes, when compared with their self-directed learning behaviors. The effect size of those statistical differences however was also small in this environment.
4. For students who expressed an aspirational interest in using digital tools or using traditional means to explore careers, the relationship between the eight learning behaviors was positive for both sub-groups. However, the strength of those relationships in all eight behaviors was stronger for the students who wanted to use digital tools than the students who wanted to use traditional approaches. Shared variances for the social media oriented behaviors were strong for each group and similar in size.
5. Within a subset of student responses from six diverse middle schools and junior high schools, the predominant digital tools being used to self-direct learning around areas of curiosity or interest were online videos and websites derived from Internet searches, followed by online or digital games. A smaller subset of students are tapping into social media tools to drive their self-directed learning. This pattern measured by frequency that the tools are mentioned in the narrative responses was relatively consistent across the three primary NCES locale codes (urban, rural/town and suburb) and the six schools.

6. Four primary purposes or motivations emerged from the analysis of the students' narrative responses about their self-directed learning behaviors. Each of the four identified primary purposes, self-remediation, skill development, curiosity and college preparation, were present in the responses from students at all six study schools. The analysis also yielded new findings about the differences in the purposes such as whether the self-directed activity was planned or spontaneous and how different digital tools supported the various purposes.

Based upon these key findings, the hypothesis about the behaviors, characteristics, values and purposes of the free agent learner is validated. In the following chapter, I will discuss how these findings align with the literature and the theoretical framework that is the foundation for the study, and the implications of this research on education leadership as well as policymakers and researchers.

CHAPTER FIVE: DISCUSSION

Introduction

The primary goals of the discussion chapter are three-fold. First, to synthesize the results from the quantitative and qualitative analytical procedures to reveal findings that both support and extend the current literature on the topic of students' digital learning. Included in the synthesis is an examination of the use of self-determination theory (SDT) as a theoretical foundation for understanding students' motivations and interests in using digital tools, content and resources to self-direct learning outside of school. Second, to discuss the analysis of the students' narrative responses about their self-directed learning behaviors to potentially advance a grounded theory about students' purposes for those digital activities. Third, to consider the implications of this research and the findings for K-12 education leaders, policy makers, and researchers in the field. The chapter is structured to address these primary goals sequentially.

The significance of this study is directed connected to the implications of the research and findings for practice and policy. In particular, the issues of access and equity associated with technology will be discussed. Technology has the ability to narrow the knowledge advantage divide. All students can visit museums, even if virtually, via the Internet. All students have access to experts in any given field by virtue of the Internet. Everyone has access to the Library of Congress. These advantages are no longer limited by proximity and/or ability to travel, money to fund the travel and admissions, or parent ability to provide such rich experiences.

The literature discussed in Chapter Two established four realities regarding the state of education and digital learning today. Technology use in school to support student learning continues to lack the requisite sophistication or strategic value to drive education transformation. Educators also persist in devaluing students' use of digital tools outside of school as frivolous or not relatable to the more important work for learning that they believe happens exclusively in their classrooms. However, the increasing access that students have to technology outside of school, their inherent curiosity about the world and their desire to be well-prepared for future success provides a timely opportunity to develop a new perspective on the value of students' purposeful use of digital tools outside of school. Finally, the increased demand from higher education and employers that students develop a new set of college and career ready skills which inherently includes the use of technology, is putting a new focus on the classroom learning experience and the resulting outcomes relative to students' capacities for future success.

From a strengths-based perspective, it is therefore imperative that today's education leaders tap into the rich experiences that students are having outside of school with technology to support and maximize the learning experience. Students' use of emerging technologies such as games, social media and mobile devices to pursue self-directed, interest-driven learning beyond educator sponsorship or direction provide a treasure trove of competencies and information that can be better leveraged to both increase student engagement in learning, as well as to support student and teacher skill development. Trespalacios, Chamberlain, and Gallagher (2011) state that a significant leadership challenge, therefore, may be for educators to develop the will to both envision the future and to create new learning environments that position students for success in the globally information-intensive economy and society. The critical significance of this study therefore is to provide education leaders and policymakers with a new understanding about the 24/7 digital learning experiences of today's students. It is my hope that our leaders will leverage this knowledge to support the development of school cultures and the types of learning experiences that all students need to fulfill their potential to become our world's future leaders, innovators and engaged global citizens.

As a review, the primary research question driving the study was to identify the learning behaviors, characteristics and purposes of students who are using digital tools to pursue self-directed, interest-driven learning outside of school. To explore that primary question, this study examined the validity of a working hypothesis on the activities and values of the *free agent learner* derived from the literature and my previous research. Since learning and curiosity are inherent characteristics in children and their development, all students are considered *free agent learners*. The working hypothesis is as follows:

Students are exhibiting the characteristics and behaviors of free agent learners when they use digital tools, resources and content outside of school to self-direct learning around areas of academic passion or personal curiosity, and these activities align with the identifying characteristics of self-determination theory (autonomy, competence and relatedness) and demonstrate a purposeful reason for the self-directed actions.

Given this working hypothesis, the following two secondary research questions were central to the subsequent analytical procedures used with both the quantitative and qualitative data extracted from the Speak Up 2014 data set.

RQ1: How are students using digital tools, resources and content outside of school to self-direct learning?

- What tools are these self-directed learners using with regularity?
- Are there relationships between these self-directed behaviors that are significant to understanding this emerging phenomenon?
- Are there significant differences or similarities in these learning behaviors predicated on gender, technology skill assessment, home Internet access, student interest in a specific career field, or school community profile?
- How do the self-directed, interest-driven digital learning behaviors support self-determination theory?
- Are there relationships between students' self-directed learning behaviors and their attitudes about learning in general?

RQ2: What purposes are driving the ways students are using digital tools, content and resources outside of school to self-direct learning?

- What are the most common purposes identified by the students?
- Are there differences in the purposes stated by students for their self-directed learning activities that are based upon the type of tool used for the self-directed learning or school community profile?

Chapter Four included a comprehensive review of the results of the various analytical tests, procedures and coding strategies used to address these questions. The results provide a solid foundation for a new understanding about self-directed, interest-driven, digital learning. Based upon those results and the synthesis of the findings into a new *free agent learner ecosystem*, I believe that the working hypothesis about the behaviors, characteristics, values and purposes of the free agent learner is validated. The following discussion of the findings both supports and extends the literature, and provides further explanation of the validation of the hypothesis included defining the *free agent learner ecosystem* and advancing a grounded theory about students' purposes for their self-directed, digital learning behaviors.

Discussion of Study Findings

The concepts of time, place and setting, so revered and institutionalized within traditional education, have new meaning when discussing interest-driven learning, and the advantages of technology to support the learning activity. Several researchers have advanced that learning fueled by a combination of students' self-directed interests and appropriate digital tools transcends the traditional boundaries established by school and home and the result is a rich array of learning experiences that are seamlessly integrated throughout the student's day (Barron, 2006; Erstad, 2012). Dodge, Barab, Stuckey et al. (2008) refer to this virtual space as the *third place* for learning, beyond the physical spaces and limitations of school or even home. As discussed in Chapter Two, several researchers have attempted to codify these behaviors into new frameworks that recognize that learning does not exist in isolation for today's student but rather happens across a variety of settings and through a seamless flow of practices from morning to night. For example, Erstad's *learning in motion* framework which describes how students operate in both physical and virtual spaces to support interest-driven learning is similar to Barron's *learning ecology* concept in that the student is able to extend interest and expertise across various settings. The findings from this study provide another opportunity to explain the lived experiences of students who are using digital tools to purposely self-direct learning beyond the sponsorship of their teachers or school. Extending the work of Barron and Erstad, the *free agent learner ecosystem* explains what types of students are self-directing their learning around interest-driven topics, what tools they are using to scaffold these learning behaviors and experiences, and the motivations that are driving these emerging learning behaviors that are occurring in a virtual space. The discussion of motivations or purposes behind the self-directed learning activities emerges from the data synthesis as a new grounded theory.

The Free Agent Learner Ecosystem: Participants

To define the participants in the *free agent learner ecosystem*, the study chose to investigate differences in students' self-directed, interest-driven digital behavior based upon three personal characteristics (gender, self-assessment of technology skills and interest in a STEM career field) and one environmental asset (access to Internet connectivity at home). The selection of gender, technology skill and home Internet access as entry points for the investigation was precipitated by previous studies that followed traditional norms by disaggregating their results using these demographic identifiers as potentially significant for a technology-related study. Home Internet access in particular has become a proxy identifier for family poverty. The inclusion of students' interest in a STEM field was suggested by several studies that focused on the use of digital tools in school to support science, math and engineering learning (Franklin & Peng, 2008; Mouza, 2008; Silseth, 2012). A common goal today of digital tool usage within the STEM curricular areas is to drive increased student interest in those fields for a career pathway. Additionally, the distribution of students interested in the self-directed digital learning behaviors based upon their attitudinal preferences for learning (i.e., I like learning how to do things, I like learning about new ideas) was also examined to better understand the profile of the free agent learner.

There is not a defining profile of the free agent learner that can be easily categorized by demographics or student characteristics. Rather, it appears from the study that while gender, home Internet access, technology skills and STEM interest play a role in students' self-directed learning behaviors, the effect of those differences between the sub-groups is small. Thus, the practical significance of these factors in educational settings as consequential in defining what types of students are using digital tools to self-direct learning is small also.

For example, the middle school girls in the study were more likely to research a website to learn more on a topic, watch a video to learn how to do something, access social media tools to identify people with shared interests or to learn what others were doing or thinking about a topic, and use writing tools to improve writing skills than their male peers. The middle school boys were more likely to post questions on a discussion board or forum, find experts online to answer questions and play an online game or virtual simulation activity than their female classmates. However, while the statistical significance may be present, the practical significance of the finding is inconsequential due to the small effect size. This is significant as it may refute some outdated conventional wisdom that girls are reluctant or disinterested in using technology. Rather, as will be discussed in the section on implications, this finding supports the idea that students' interest in using digital tools for self-directed learning is not a "one size fits all" proposition and that traditional means of differentiating digital behaviors based upon students demographics such as gender may not be relevant today.

Similar patterns exist for the other studied student characteristics and assets. While differences in the frequency of the learning behaviors exist based upon students' level of access to high speed Internet at home or their self-assessment of their technology prowess, the effect size of the differences and subsequently the practical significance of those differences makes it inappropriate to define those as true disparities, especially as it relates to policy or programs. As noted earlier, students increasing access to Internet enabled devices in their pockets and backpacks changes the connectivity equation when Wifi hot spots are prevalent within the community. The hard-wired, high-speed broadband connection at home is less relevant to the student who is using his smartphone during passing period in school to quickly look up information about the intriguing historical figure just discussed in the previous class. The implications of this change in perspective on the type and quality of the Internet connection should be of high interest to policymakers as will be discussed.

Differences in students' attitudes about learning preferences (liking learning about ideas, liking learning how to do things) was consistent with the results from the analysis of gender, technology skill assessment and Internet access as potential indicators of students' self-directed learning. The differences were significant but small in effect, and thus potentially unreliable as a way to define the free agent learner.

The analysis of the learning behaviors of students with and without an interest in a STEM career field yielded an interesting finding that was subsequently echoed in other findings. While only small statistical and practical differences existed between these two subgroups of students on six of the eight learning behaviors, no difference was evident for the two social media oriented activities; using social media to identify people with shared interests and to learn what others are doing or thinking about a topic of interest. Social media usage therefore transcends students' curricular or career interests in science, technology, engineering and math. The analysis of the narrative responses from the students about their self-directed learning behavior noted a complimentary finding. While students researching websites and watching videos often mentioned math and science topics as the focus of their self-directed behaviors, the majority of the students' responses about their use of social media tools were devoid of references to curricular topics and more focused on general learning.

Education practitioners and researchers often look for discrete ways to categorize behaviors or attitudes, often relying upon student demographics or characteristics to define a population or to explain a phenomenon. The existing body of research on students' self-directed, interest-driven use of digital tools outside of formalized education settings have favored small scale case studies, observations and limited qualitative or descriptive approaches to understanding this emerging trend (Ross, Morrison & Lowther, 2010; Selwyn, 2007). Additionally, some limited studies have focused on the logistics and interpretations of students' use of discrete types of digital media or tools (i.e. digital games, online communities, mobile devices) rather than developing a learning ecology perspective on the interlaced media culture to explain how the technology is supporting students' motivations for learning (Drotner, 2008).

The dearth of quantitative data from students on their lived experiences using digital tools beyond adult sponsorship presented an opportunity for this study to specifically balance rigor with applicable relevancy to real world education settings. The outcomes from this study which used the large Speak Up dataset with 133,212 cases subsequently has the potential to change existing perceptions and challenge longstanding mythology about students' digital learning experiences outside of school. The finding therefore that the participants in the *free agent learner ecosystem* defy easy or traditional categorization and represent girls *and* boys, tech savants *and* tech novices , students with access to high speed Internet at home *and* those that may be accessing learning content through a Wifi hot spot at McDonalds, as well as students with varying levels of interest in STEM fields is an important outcome from this study. This inability to confine the student profile for the free agent learner to only students exhibiting certain behaviors or demonstrating particular attributes or assets is a defining characteristic of the *free agent learner ecosystem*.

The Free Agent Learner Ecosystem: Behaviors and Tools

In her seminal work on how today's youth are living and learning with new media, Ito (2010) in collaboration with colleagues synthesized the research from 27 empirical studies that explored how students used emerging technologies such as social networking, games, online communities and digital media production tools to support friendship-driven learning and interest-driven learning. From the studies, the researchers identified three genres of participation (*hanging out, messing around and geeking out*) that describe students' varying levels of investment or participation in these new media tools. Per the working hypothesis on the free agent learner, the focus of this study is on how students are using digital tools to satisfy personal curiosities or pursue academic passions. These activities most closely align with Ito's concepts of *messing around* and *geeking out.* The findings from this study extend the work of Ito and her colleagues to quantify the types of digital tools that are enabling the self-directed learning behaviors and explore potential relationships between those behaviors. The behaviors and tools in this context therefore become the scaffolding for the *free agent learner ecosystem*.

The study examined the frequency of students' participation in eight specific self-directed digital learning behaviors as follows:

- Research a website to learn more on a topic (LB #1)
- Watch a video to learn how to do something (LB #2)
- Post a question on a discussion board or forum (LB #3)
- Use social media to identify people who share my interests (LB #4)
- Use social media to learn what others are doing or thinking about a topic that interests me (LB #5)
- Find experts online to answer my questions (LB #6)
- Play an online game or virtual simulation activity (LB #7)
- Use online writing tools to improve my writing (LB #8)

Six of the eight behaviors used a distinct tool such as a video or an online game. The two social media oriented behaviors differed by purpose rather than tool or product. Student participation across the eight behaviors varied. The most popular behaviors amongst the study's middle school students were watching a video to learn how to do something and researching a website to learn more about a topic. Playing an online game or virtual simulation activity was also a behavior noted by a significant percentage of the student population. The other behaviors were less popular but not without participants who still expressed that they did those activities with high frequency. Those less frequently reported behaviors included online activities that represent more sophisticated technology knowledge than simply researching for a website; activities such as posting a question to a discussion board or using the Internet to seek out experts to answer questions. These findings, about the frequency of certain digital tools used to self-direct learning, was also evident in the analysis of the students' narrative responses. Across all six schools in that study representing a variety of community types and student demographics, the most frequently used tools were videos and websites.

This finding is consistent with expectations. The pervasiveness of two brand names within popular culture today, YouTube and Google, almost foreshadow the finding. Videos and websites represent easily accessible participation points for self-directed learning for students in all grades. To access those resources, students do not need to register, open an account or establish a profile to participate such as is the case with social media tools or discussion boards. Most website and video resources are free and thus again the barrier to entry is potentially lower than playing an online game that may require a paid license. Additionally, with increasing student access to the Internet through mobile devices (even low cost versions) and public WiFi connections, students have the capabilities for Internet searching for websites or videos in the palm of their hand. Comparatively, the use of writing tools to improve writing is a more deliberate self-directed learning behavior, which requires some planning and access to the right tool set. Watching a video or researching websites also support the type of spontaneous, non-linear learning identified by Drotner (2008) as "collage creativity" in what students pursue finding information when their curiosity is aroused. This stands in contrast to the highly structured, knowledge attainment and assessment practices common in most school-based settings. The students' narrative responses that exemplified the purpose or motivation of their self-directed learning as curiosity was laden with this type of "just in time" learning.

In following the discussion about the profiling of free agent learners, it is also important to note that students are not exclusive in their use of one digital tool to facilitate their self-directed learning. Rather, following Drotner's (2008) research, students weave together a personally curated set of tools to support their learning. Within the narrative responses, many students identified multiple types of tools such as videos, websites, discussion boards and social media to support their learning, often with different purposes identified. Ito (2010) found a similar pattern of students simultaneously watching a video and communicating with other students using social media as standard procedures. Therefore, it was instructive to examine the relationships between the various self-directed learning behaviors in this study to understand which tools may be best aligned to these personally curated digital tool kits.

Positive relationships existed between all of the self-directed digital learning behaviors with some exhibiting stronger connections than others did. Three are worth further discussion. The strongest relationship was between the two social media oriented activities. The two behaviors represent two different purposes behind the social media usage. Thus, the strong relationship indicates that students interested in finding people online who share their interests are also most likely interested in then following those people on platforms such as Twitter, Instagram or Pinterest to learn what they are thinking or doing about that shared topic of interest. Students are therefore not differentiating those learning behaviors as fundamentally different experiences.

A medium strength relationship exists between watching a video and researching a website. As discussed earlier, both of those behaviors most likely represent an easily accessible entry point for self-directed learning without many of the barriers associated with the other behaviors such as cost to participate or requiring advanced technological skills. This probably makes these tools, videos and websites, especially appealing to middle school students who may legally be too young to register for a social media account or not have the types of access at home to support more sophisticated or sustained usage.

The medium strengthened relationship between the social media oriented activities, posting a question on a discussion board and seeking experts online to answer questions represents a collection of learning behaviors that can be associated with Boyd's (2007) concept of *networked publics.* In this sense, the online communities, discussion boards and social networking sites facilitate student sharing of interests and expertise and provide opportunities for students to learn from each other and other experts. Boyd's work was focused heavily on the friendship driven aspects of these *networked publics*, but the results of this study indicate that the free agent learners who are using these digital tools to pursue academic passions or personal curiosities also value the *network public* type tools as a curated set for learning.

Just as a house has walls and a roof to support its functionality as a domicile for protection from the elements, digital tools and self-directed learning behaviors provide the scaffolding for supporting the *free agent learner ecosystem*. The tools and behaviors explain what the free agent learners are doing within their personally directed and managed ecosystems. The quantitative analysis on the frequency of the usage of certain tools and the relationships between the self-directed learning behaviors both substantiate and significantly extend current research on how students are using digital means to support interest-driven learning. The synthesis of these findings also provides both practitioners and policymakers with a new appreciation for the practical significance of research such as this study.

The Free Agent Learner Ecosystem: Motivations

A common misperception many educators hold is that student self-directed use of technology outside of school is only for entertainment or relationship development (Boyd, 2007; Clark, Logan, Luckin, Mee, & Oliver, 2009: DeGennaro, 2008; Greenhow & Robelia, 2009b; Harlan, Bruce, & Lupton, 2012; Ito, 2010; Prensky, 2008; Spires et al., 2008; Squire & Dikkers, 2012). A nascent set of research is discussed in the review of the literature that presents a case for how students are using digital tools and resources to self-direct learning around academic interests and skill development of high personal value to them. Ito (2010) characterizes this interest-driven digital learning as learning experienced through interactions with peers that share similar interests and the ability for students to explore their identity, express themselves, give feedback to others and follow passions that are not standard within school curriculums. In contrast to the use of technology in adult-sponsored learning spaces, within the student interest-driven paradigm, both content and modality is inherently student initiated and directed. The increasingly ubiquitous availability and access of new media tools to students is the fuel that is enabling this new learning paradigm. As the third rail of the *free agent learner ecosystem*, understanding students' motivations and/or purposes for their self-directed learning extends the research of Ito and others beyond the what, where and how of these behaviors and provides new research on the why of interest-driven learning.

This study is situated on a foundation established by self-determination theory (SDT) (Ryan & Deci, 2000) and contextualized by the work of Pink (2011) and Wagner (2010, 2012). SDT postulates that intrinsic goals are directly linked to the satisfaction of three basic psychological needs; autonomy, competence and relatedness. The study aimed to examine if the use of digital tools and resources supported students' abilities to self-direct their own learning based upon personal interest choices (*autonomy*), to enable social learning environments that enabled connections and relationships (*relatedness*), and to establish personalized strategies that drive self-efficacy and agency as a learner (*competence*). The working hypothesis for the study identified free agent learners as those students intrinsically satisfying those basic needs.

Additionally, Pink's (2009) theories on motivation help us understand why students may be interested or motivated to pursue self-directed digital learning. It is human nature to be curious. Acting upon that curiosity requires a level of self-directedness and individual initiative in most cases. The ability of the student to find appropriate and accurate information, resources and experts on this topic requires self-directed learning that is individually sponsored. The learner in this case is satisfying a desire for *autonomy* in the learning process. Taken to the next step, Pink also proffers that engagement in an activity such as learning is part of the process of developing mastery or *competence*, an important component of self-efficacy. While autonomy and mastery are important components of motivation, the fuel that drives the engine for personal motivation is purpose. Similarly, Wagner (2012) also identifies purpose or the identification of intrinsic goals as a key component to understand how today's students are motivated differently, especially as it relates to school-centric learning. Reminiscent of the results from Ito's (2010) studies, Wagner says that students want to learn through connections with others (*relatedness*), self-directed discoveries, and creation of content or different ways to display their knowledge or skills. This type of learning experience Wagner believes allows students to become not just self-directed leaners but effective innovators armed with the requisite skills necessary to be successful in a global, information-intensive society. Whereas Pink provides the context for understanding how SDT drives personal motivation, Wagner establishes the importance of the self-directed skills for future success, an important consideration for education leaders today given the emphasis on college and career skill readiness for all students. Thus, the inclusion of a demonstration of purpose within the self-directed learning research hypothesis was a highly deliberate and strategic insertion.

To understand what is driving the engine of personal motivation for self-directed learning within the *free agent learner ecosystem*, this synthesis of the findings examined purpose from two perspectives. First, the relationship between the students' self-directed learning digital learning behaviors was evaluated relative to the learning outcomes they anticipated from technology usage. Second, a grounded theory about the purposes driving self-directed digital learning emerged from the qualitative analysis of the students' narrative responses to an open-ended question.

Learning outcomes were interpreted within the construct of the three basic psychological needs identified by SDT:

- Autonomy:

    - I am able to learn at my own pace
    - I have more control over my learning
- Competence:
    - I am developing critical thinking and problem solving skills
    - I am developing creativity skills
    - I spend more time mastering a skill or learning something
- Relatedness:
    - I work together with my classmates more often
    - I participate more in class discussions

Students that valued these six outcomes from technology use were more likely to participate in self-directed digital learning behaviors than students who did not. Statistical significance existed across all eight self-directed learning behaviors for each outcome. It is therefore reasonable to expect that students who value the basic need of competence (articulated here as ability to learn at one's own pace or being in control of ones' learning) would be also exhibiting behaviors associated with self-directed learning. As demonstrated through other findings, the effect size of that statistical significance was small however across all of the compared behaviors and outcomes.

Understanding that the small effect size may limit the practical significance of the results, the findings however provide value in two additional realms. From a research standpoint, the findings are significant in understanding the value of SDT as a framework for examining the intersection of student digital learning outcomes and self-directed digital learning behaviors. A few previous studies examined the role of SDT in students' use of digital tools within a school setting (Zhao, Lu, Wang & Huang, 2011; Moos and Honkomp, 2011). In this study, the learning outcomes represent a specific contextually relevant educational interpretation of the three basic psychological needs of SDT. This places a higher value of these findings for educational research. More importantly, the comparative analysis with the self-directed digital learning behaviors connects the tenets of SDT with purposeful learning that is beyond the sponsorship of teachers and other adults, a strong differentiator from the previous studies.

The findings also indicate that the purposes or motivations as articulated by the learning outcomes may be clustered around certain sets of digital tools and behaviors. An analysis of the intersection between the relationships between the self-directed learning behaviors and the significance of the learning outcome differences enables these new findings. For example, the learning behaviors that have an interpersonal component (the social media oriented behaviors and finding experts online to answer questions) have a medium to large strength of relationship between the behaviors and represent the highest effect size for the relatedness outcome statements. While the effect size may still be small, it is apparent that students interested in the learning behaviors that inherently involve connecting with other people, are also most likely to value technology that results in stronger relatedness. As educators think about how to support students' development of college and career ready skills such as effective communications and collaboration abilities, it would be prudent to be open-minded about encouraging students to use social media tools and online communities to develop competence in these areas in school as well as encouraging out of school usage. The same pattern of findings also exists for the competence and autonomy outcomes, and thus provides additional implications and new opportunities for educators to understand the motivations and purposes for students' self-directed digital learning.

The second approach undertaken involved the analysis of students' narrative responses to an open-ended question about their self-directed digital learning behaviors. The question specifically asked students to identify the digital tool that they used for their self-directed learning and the purpose for that behavior or activity. The use of a constructivist grounded theory approach to the analysis of the students' narrative responses led to the emergence of four primary purposes driving students' self-directed digital learning behaviors. The practical utility of the *free agent learner ecosystem* is significantly enhanced by understanding what drives students to independently use digital tools outside of school (autonomy) to develop connections with others (relatedness) and skills and proficiencies beyond what is accomplished during the school day (competence). The following section describes the grounded theory emerging from the analysis.

A Grounded Theory on the Centrality of Purpose in Self-Directed Learning

Ecosystems are environments where change is the norm, not the exception. Such is the case with the *free agent learner ecosystem*. This study focused on the self-directed learning behaviors of students in grades 6, 7 and 8 who reported using a variety of market available digital tools to satisfy needs driven by their current perceptions of the world, their random curiosities or deficits in their learning lives in school. While the study captures a moment in time about these students and their self-directed learning behaviors, it should also be appreciated that the digital tools available today to enable the self-directed learning behaviors studied may be obsolete tomorrow, replaced by a new set of technologies that empower different learning behaviors. Student needs and interests inevitably change with maturation but may also be affected by changes in the types of job skills required in the increasingly information intensive global society, and their learning environments in school. The three elements therefore of the *free agent learner ecosystem,* the participants, the behaviors and tools, and motivations, are not static entities, but rather are reflectors of the changes in society, technology and education.

To accommodate the inherent dynamism within the phenomenon of students' self-directed, interest-driven digital learning, a new grounded theory is proposed. This proposed theory provides an explanation of the interlocking relationship between the three basis psychological needs espoused by SDT, the self-directed learning behaviors exhibited by the students, the digital tools enabling those actions, and the purposes driving the behaviors. A key value of this new theory is that it provides a framework for understanding students' self-directed learning outside of school that is not dependent upon a particular digital tool or online resources as the explanatory factor. Rather, the grounded theory about the centrality of purpose in students' self-directed, interest-driven digital learning starts with an examination of the learning needs and desires of students that is instigating these behaviors.

As discussed earlier, this study was important to address three primary deficiencies or gaps in the current research. The majority of the research available focuses on the use of digital tools or resources during the school day or in afterschool and summer programs where the use of the technology is typically sponsored, structured and directed by an adult such as a teacher, informal educator or program director. While a nascent set of research aims to understand how students are using digital tools outside of school, the research in that area has favored small-scale case studies, observations, and other limited qualitative or descriptive approaches (Ross, Morrison & Lowther, 2010; Selwyn, 2007). Additionally, the limited studies have usually focused on the logistics and interpretations of students' use of discrete types of digital media or tools (i.e. digital games, online communities, mobile devices) rather than developing a learning ecology perspective on the interlaced media culture students are experiencing (Drotner, 2008). However, a common sub-theme throughout the most recent literature on students' use of technology tools outside of school is that the activities are highly purposeful, with a clear intent in terms of why the students are using particular tools, and the ends that they hope to achieve through those activities (Ahn, 2011; Boyd, 2007; DeGennaro, 2008; Erstad, 2012; Fewkes & McCabe, 2012; Ito, 2010; Ke, 2008; and Stevens, Satwicz & McCarthy, 2008). As articulated in the results section, this study identified four primary purposes driving students' self-directed digital learning: self-remediation, skill development, curiosity and career preparation.

The results of the study including the discussion in this chapter about the participants, tools and behaviors, and motivations within the *free agent learner ecosystem*, strongly suggest that purpose is central to students' self-directed, interest-driven digital learning. At the onset, purpose first defines the need or desire that is driving the self-directed learning actions. Then, given the specific purpose, students chose the digital tool or tools best suited to address their learning need or curiosity. The resulting learning behaviors are strongly connected to the particular purpose that is instigating the actions and the related functionality of the digital tools selected. Purpose also defines the frequency or regularity of that action, and which of the three basic psychological needs from SDT are met; autonomy, competence or relatedness. The following student scenarios illustrate the centrality of purpose to students' self-directed digital learning. A selection of students' narrative responses to the open-ended question on the Speak Up survey provides the background for the scenarios and resulting discussion.

Scenario 1. *"I often use khan academy when I don't understand my algebra 1-2 class. Doing the questions instead of just writing notes verbatim helps me in ways that a traditional classroom could not."* (7^{th} grade girl, School A)

As articulated by this 7^{th} grade student from an urban community, the purpose of her self-directed learning is to address her lack of understanding of content in her Algebra class. In my interpretation of the purposes identified by students, this one qualifies as an example of self-remediation. To address the need that she has to gain a better understanding of some Algebra concepts, she says that she often (*the indicator of frequency*) uses Kahn Academy (*the digital tool, an online repository of videos demonstrating different ways to solve math problems*) to acquire that needed understanding. Additionally, she points out that the learning experience acquired through the watching of the videos (*the learning behavior*) helps her learn in a different way that her classroom experience (*satisfies need for competence*). The impetus for her self-directed learning behavior, the choice of the digital tool, the frequency of the behavior and the resulting satisfaction of a basic psychological need is all driven by her central purpose to gain a better understanding of Algebra.

Scenario 2. *"I use my cell phone and my computer everyday to watch videos either on how to bake things, a new dance move, or how to build something."* (6th grade girl, School C)

For this 6th grade student, the purpose of her self-directed learning is to learn how to do things, what I interpreted in the analysis as a purpose of skill development. To address her desires for baking, dancing or building, she is using her phone or computer everyday (*the indicator of frequency*) to watch videos (*the digital tool, the learning behavior)* to develop new skills. For this student, this is her interpretation of a type of self-directed learning that satisfies a need for *competence* as well as *autonomy*. The impetus for her self-directed learning behavior, the choice of the digital tool, the frequency of the behavior and the resulting satisfaction of the basic psychological needs is all driven by her central purpose to develop new skills.

Scenario 3. *"The way I use technology to learn new things outside of school is that sometimes when I learn about a new person or thing, I like to learn about it. So sometimes during passing or after school I look up the person or thing and read a couple articles about it. The websites I usually use are old news stories or bios about the thing or person. For example, in social studies when I learned about the Marbury vs Madison trial, I was very interested about it. And I ended up learning more about it."* (8th grade girl, School A)

The purpose of this student's self-directed learning activity is to learn more about something that she learned about in school. Her purpose is therefore driven by a curiosity for learning. To address the need she has to learn more about a person or thing, she notes that she sometimes (*the indicator of frequency*) uses websites, old news stories or online articles (*the digital tools)* to satisfy that curiosity. The *learning behavior* includes a variety of activities such as "looking up" information and reading articles or stories. Ultimately she notes that she learns more from that experience (*satisfaction of a need for competence*). In this case the impetus for her self-directed learning behavior seems to have originated in a school-based learning environment. She extends that learning experience to become a self-directed, interest-driven opportunity through the choice of the digital tools, the frequency of the behavior and the resulting satisfaction of the basic psychological need. Throughout each of those processes, the central purpose for her actions, the curiosity about people or things, is driving the behavior.

Scenario 4. *"Sometimes I go on Google and search about my future job and what it takes to succeed in that career. Also, I look up colleges that have my profession that I want to major in."* (8^{th} grade girl, School F)

For this student in a rural community, her use of digital tools outside of school is in service of learning colleges and future careers. I defined this purpose as career preparation. To address her desire to learn about colleges and careers, she sometimes (*the indicator of frequency*) goes to Google (*her digital tool of choice to search for information).* The searching for the information is the self-directed *learning behavior*. The student notes that she is searching for "what it takes to succeed," a need that can be defined as both *competence and autonomy* per SDT. As illustrated in each of the featured scenarios, the purpose of her actions, in this case a desire for career preparation, drives the choice of the digital tool, the frequency of the behavior and the resulting satisfaction of the basic psychological need.

The centrality of purpose within students' self-directed learning activities outside of school is supported by Pink's (2009) premise that what motivates people toward competence or mastery is purpose. The proposed grounded theory on the centrality of purpose within student's digital behaviors has roots in Wagner's (2012) identification of intrinsic goals as driving students' motivations to learn differently than the way they are learning in school. The proposed theory therefore emerging from this study both extends the current research that acknowledges that purpose plays a role in students' digital lives, and stands on the shoulders of SDT and the work of Pink and Wagner. Additionally, the focus on purpose as the driving force behind students' self-directed learning supports the quantitative results from this study that were inconclusive on identifying free agent learner profiles based upon the traditional demographic identifiers or even student accessibility to technology. Rather, as espoused initially in my working hypothesis and now in this proposed grounded theory, students are exhibiting the characteristics and behaviors of free agent learners when they use digital tools, resources and content outside of school to self-direct learning around areas of academic passion or personal curiosity, and those activities align with the characteristics of SDT and *demonstrate a purposeful reason for the self-directed actions.*

Understanding purpose has a double benefit in this discussion. First, it is the key to a greater appreciation of how, when, where and why today's students are pursing self-directed digital learning outside of school, and second, it provides a sustainable construct for examining how tomorrow's students may use the next generation of digital tools to self-direct their learning as well.

Limitations

Revisiting limitations on the generalizability of the research or the methodology utilized to address the research questions is an appropriate activity for this discussion. There is value in the reflection on the original limitations for future studies. For this particular study, I had originally identified two specific limitations that warranted awareness and cognition throughout the study process. Additionally, the study process produced an additional limitation not previously identified.

First, while the Speak Up 2014 data set was very large, it was a convenience sampling and some may question the generalizability of that sampling type. As discussed in Chapter One, the convenience aspect of the sampling is at the school or district level, not at the student level. Thus, any potential bias within the data toward students who are technology sophisticates is minimized since school and district leaders make the decision to have their students take the survey. To mitigate that claim further, however, my Phase II quantitative data analysis focused exclusively on schools where over 75 percent of the school population completed the survey. Additionally, the analysis included tests for normality as well as an examination of correlations looking at the relationship between students' self-directed digital learning and their self-assessment of their technology skills as well as their access to the Internet at home. The results of statistical tests comparing the frequency of the self-directed learning behaviors for students with high speed Internet access at home with students who had slow or no access at home indicated a statistically significant difference but an effect size (or practical significance) that was small. The generalizability of the findings does not appear to be compromised by the convenience sampling methodology used for the data collection.

The second potential limitation of the study that I noted originally was a perception that my own positionality as a researcher and advocate for digital learning for almost twenty years will affect the interpretation of the findings. To that point, I wholeheartedly agreed at the onset of the study, and continue to endorse as an asset rather than a liability.

The way I approached the findings was definitely shaped by my prior experiences in analyzing the Speak Up data over the past thirteen years and conducting over 30 focus groups and panel discussions with students about their technology use, both in school and out of school, each year. However, rather than assuming that my positionality would mean a rose-colored glasses' approach to the data findings, I believe that the opposite is more accurate. Given my in-depth familiarity with the issues discussed in the literature and in the Speak Up data to date, my typical posture has always been to question quick assumptions regarding students' digital activities and to examine any data from the Speak Up Project or other sources with a highly objective and analytical approach to uncover deeper meaning. I employed that same approach with the analysis and interpretation of the data used within this study and the development of the findings. To further leverage this asset, I employed a constructivist grounded theory approach to the analysis of the qualitative data used in Phase II of the study. Within this constructivist approach, the researcher is considered an author, and the experiences and expertise that he/she brings to the coding and analysis of narrative content is considered valuable and expedient. This approach was especially useful during the process of reading and interpreting the responses from middle school students to an open-ended question on the survey. My understanding of the types and names of various digital tools and products used by students today, and the ways student typically discuss technology use today helped to elicit deeper meaning from the qualitative data and to advance a new grounded theory about the centrality of purpose within the students' self-directed learning behaviors. Additionally, I think my familiarity with the state of digital learning in our schools today provided a more informed context for discussing the implications of the findings for education leader and policy makers. For this study, my positionality was an asset throughout the research process and analysis and reporting of the findings.

An additional limitation not originally noted but emerging from the findings is worthy of mention now. While the Speak Up dataset provided a very comprehensive set of data to work with for this study, at times during the analysis process that I wished I had more data on the individual student demographics within the study population. By design, the Speak Up project does not collect identifying information about students' racial/ethnic or cultural heritage or family income. To explore those important criterion, I used proxies such as school level demographics and students' reported access to the Internet at home as an indicator of family poverty. Though sufficient for the statistical analysis mandated by the purposes of this study, future studies may want to be more definitive about exploring those factors.

Conclusion: Implications of the Study Findings

An awareness of the free agent learner ecosystem, and appreciation of the centrality of purpose driving students' use of digital tools, content and resources outside of school to self-direct their learning, be it for self-remediation, skill development, curiosity or career preparation, has important implications for education leaders and policy makers. Additionally, given the nascent nature of this research, a potential new topic for further study by educational researchers is presented as well.

Education Leaders. As the primary intended audience for the results from this study is education leaders, it is especially important for the discussion on the implications for the study findings to be highly contextualized for school and district administrative leaders as well as teacher leaders in classrooms. In noting the cultural, personal and professional barriers that inhibit the use of research findings in K-12 school settings, Fusarelli (2008) recommends presenting findings in a manner that is easily consumable by the often time-deprived education leader and explicitly connecting the value and relevancy of the research to the school environment. Carnine (1997) underscores the criticalness of contextualization in bridging the gap between research and educational practice. Carnine’s interpretation of contextualization includes both the practical usability of the research within education settings and the accessibility and readability of the findings. To that end, this discussion on the implications for education leaders specifically aims to connect the existing literature with the study findings and to draw connections with current issues facing K-12 leaders and educators in general.

The findings from this study have implications for two challenging issues facing education leaders today. The twin challenges of improving student learning outcomes and changing school cultures to support education transformations are top of mind issues for most education leaders.

Driven by the implementation of Common Core State Standards, student learning outcomes are increasingly being defined relative to the workplace skills students need to thrive and compete in the increasingly information-intensive global economy and society.

Wagner's (2012) work on the ineffectiveness of traditional education to support the development of creative problem solving and innovative thinking skills illustrates why this is such a perplexing challenge. At the heart of his argument is that traditional school environments are not focused on the skills that students need to be successful in the future (2008). The traditional classroom rewards individual achievement rather than the success of collaborative efforts, is organized around communicating specific subject content rather than exploratory learning skills, and relies upon extrinsic motivations such as grades and test scores rather than the intrinsic motivators such as play, passion and purpose (pg. 57). In stark contrast is how today's students, who Wagner calls the *Innovation Generation*, want to experience learning. Reminiscent of the results from Ito's (2010) studies, Wagner says that students want to learn through connections with others, self-directed discoveries, and creation of content or different ways to display their knowledge or skills.

The findings from this study support those conclusions by demonstrating how students are already using digital tools outside of school to create the types of learning experiences both Ito and Wagner espouse. Students shared many examples of these experiences in their narrative responses such as using writing sharing sites to gain feedback on their personal writing as a way to improve their skills and their use of social media tools to learn about what others are thinking and doing around topics of personal interest to them. The middle school students using digital tools outside of school attribute their use of those technologies to the development of key workplace skills such as critical thinking and problem solving. Additionally, the self-directed learning behaviors are not limited to students of privilege or those students with certain demographic qualifications.

Rather, the use of digital tools, content and resources by students outside of school to self-direct learning appears to be a universal phenomenon characterized by a strong orientation to the purposeful motivations driving the behaviors.

Evidence of students' interest-driven digital learning, such as identified through the study findings, validates the need for education leaders to think beyond traditional learning settings and to appreciate the ways that students are self-directing meaningful learning experiences without the sponsorship of teachers and other adults. Beyond the classroom and school building walls, students are developing their own learning ecosystems that highly value collaboration, knowledge sharing and peer mentoring (Barron, 2006; Ito, 2010). This study identified a new ecosystem based upon students' self-directed digital learning, the *free agent learner ecosystem*. As discussed in this study, students' interest-driven participation with digital tools results in enhanced personal identification as learners and experts in addition to the development of the workplace ready skills that are the reportedly desired outcomes from the Common Core State Standards.

The demands for students' developing the critical workplace skills identified by Wagner (2008) and codified in the Common Core State Standards has precipitated an increased focus on the use of technology within the classroom learning experience. However, to effectively use technology to support these new learning standards, classroom instruction and teacher practice must be re-engineered to take advantage of the capabilities and to empower student self-directed learning. This process often mandates the development of a new school culture to support these efforts (Trespalacios, Chamberlain & Gallagher, 2011). A common perception held by many teachers and administrators is that the mere presence of technology within instruction promotes greater student engagement in learning. Several recent empirical studies support the relationship between student engagement and the use of technology in school, and in afterschool and summer program settings. However, these studies also identify other factors that influence and inform this linkage between engagement and technology. The research advances the idea that student engagement using technology is predicated on the existence of three conditions: 1) the authentic inclusion of students' ideas and informal experiences using technology; 2) the opportunity for students to extend their learning outside of school; and 3) the evidence of connections between students' self-directed interests and their schoolwork (DeGennaro, 2008; Franklin and Peng, 2008; Lawrence, McNeal, & Yildiz, 2009; Mouza, 2008; Silseth, 2012; Spires et al., 2008).

The findings from this study provide education leaders with evidence to support the development of new school cultures that recognize the value of students' out of school experiences using technology tools for learning. Contrary to some assumptions, students that are using digital tools for self-directed learning are purposeful in these behaviors. They are pursuing these self-directed learning behaviors to self-remediate where they believe they have academic needs or deficiencies, learning skills that can help them in school and in life, following academic curiosities often sparked by a classroom discussion or activity, and preparing themselves for the future by exploring careers and colleges. Awareness and recognition of these activities and the purposes driving students' self-directed learning may help education leaders change the perceptions of their teaching teams and start new conversations about how to leverage the students' proficiencies and competencies with these digital tools within the classroom. Operationalizing this awareness may require that the teachers (and administrators) acknowledge that they "may not be the only expert in the learning process" (Drexler, 2010, p. 374).

Finally, I think it is important for education leaders and educators in general to realize that today's students are not waiting for them or their teachers to transform the classroom learning experience to best fit their needs for skill development, to help prepare them for an uncertain future or to even to answer all of their questions about science, history or politics. That ship has sailed. Armed with Internet connectivity in their pocket, backpack or palm of their hand, students have the capacity now to self-direct learning around academic passions or personal curiosity about their world. They are using a variety of digital tools, content and resources and developing a host of new learning behaviors to support these interest-driven activities. At the center of this self-directed learning is a series of highly developed purposes that are propelling today's students to take their educational destiny into their own hands, literally. An opportunity exists for educators to learn from these student experiences and use that knowledge to spearhead a new morning in education, a morning that values students' self-directed learning experiences and aims to create in-school experiences that are innovative, relevant and purposeful.

Policymakers. Over the past twenty years, policymakers have defined the digital divide as the ability of some individuals to have access to technology, while others do not. Concentrated efforts in the late 1990s by government agencies and private funders provided investments in connecting schools and homes to the Internet particularly in rural and urban communities. As a result, since 2003 policymakers and researchers have essentially considered that the war on the digital divide of access has been won, especially in terms of school connectivity. Consequently, there has diminished interest in new research on the topic (Chapman, Masters, & Pedulla, 2010). Three new discussion topics, two originating in research and one driven by policy considerations, have started to change the discussion about the value of technology access and usage as factors essential for education equity, including how digital access can enable students to learn workplace skills essential for future success. This study helps to inform all of these emerging conversations.

Recently, researchers have started to look beyond the simplistic binary counts of who has access to technology and who does not, and examine the differences in how technology is utilized by teachers and students as a new indicator of educational equity, what some are now calling the *Second Level Digital Divide* (Reinhart, Thomas, & Torskie, 2011). In particular, the literature examines the differences in teachers' familiarity, comfort and use of technology within instruction based upon their school's economic factors, and the new barriers that underserved students need to negotiate even when they have school and home access to technology tools.

Teachers from high need schools had less developed skills and less capacity to both utilize advanced digital tools within their teaching practice, and to guide their students in their own self-directed utilization than their peers at better funded schools (Chapman, Masters, & Pedula, 2010). Reinhart, Thomas and Torskie in their 2011 study support these findings regarding the inequity in educational opportunities promoted by differences in teacher aptitude and comfort using technology. Reflecting on this linkage, the researchers noted that schools with a lower percentage of students who receive free and/or reduced lunch use technology in a way that promotes higher order thinking whereas schools with higher percentages of underserved students expose their students to only basic technology applications. Chapman, Masters and Pedulla summarized the impact of this new digital divide as follows, “what does it profit students to have technology access if both they themselves as well as those instructing them do not have the training or capacity to utilize this technology efficiently?” (p. 248).

Correspondingly, students in low-income schools with limited opportunities to use sophisticated media tools both at school and at home were less likely to develop advanced technology skills or to have the confidence to use digital tools, thus creating a new form of inequity (Barron, Walter, Martin, & Schatz, 2009; Ross, Morrison & Lowther, 2010). A similar finding was evident in this study. While we do not know about the sophistication of the digital tools or the technology skills of the teachers at the six schools in our Phase II analysis group, we can examine some resulting data and compare results within the cohort of study schools. For example, the schools with the highest percentage of students qualifying for the federally funded free lunch program (an indicator of home poverty) were Schools B and D in our Phase II analysis. Those two schools also had the lowest percentage of their students self-assess their technology skills as advanced compared to the other four schools; 21% for School B and 18% for School D. Comparatively, at School A where only 2% of their students qualify for the free lunch program, 33% of their middle school students ranked their technology skills as advanced. Students at Schools B and D also reported having less high speed Internet access than their peer at the other four schools as would be consistent with their higher percentage of students qualifying for the free lunch program.

A new policy initiative emerging relative to technology access and equity is what FCC Commissioner Jessica Rosenworcel calls the *Homework Gap* (2015). The *Homework Gap* is defined as the situation when students are assigned digitally-based or Internet dependent homework, assignments or school projects but they are unable to complete those activities due to their lack of consistent or safe access to the Internet outside of school. Many of the current policy discussions to address this challenge focus on solutions such as expanded connectivity within the neighborhoods around schools, providing students with opportunities to tap into school networks before and after school and equipping school buses with WiFi that can be shared with neighborhoods. While this renewed attention on home connectivity is valued and may be indicative of greater emphasis on digital learning in school, two additional sub-topics should be included in these discussions.

In their ethnographic research on media use by low income, Latino youth, Tripp and Herr-Stephenson (2009) discovered that even when students had home technology and Internet access they faced cultural barriers in fully leveraging these tools for informal learning. Parents' lack of knowledge about technology effectively stifled their children's abilities to use the tools for self-directed learning. Policymakers should also pay greater attention to the cultural issues associated with students' access to technology at home. A recent Project Tomorrow study (2015) noted that parents in a Latino community were giving priority to their high school aged children to use the home computer and Internet connection over their younger children in middle and elementary school. In this case, the younger children were affected by the *Homework Gap* even though the family had a high speed Internet connection into their home. While parents' understanding and awareness of the importance of digital access for all of their children needs to be addressed, it is plausible that there is simply not enough money to provide a device for each child. Parent training and awareness as well as the need to provide resources and devices to low-income families should be important topics for equity policy considerations.

Additionally, current conversations about the *Homework Gap* put a premium on the value of Internet connectivity for school assigned homework or projects, and do not address the value or need for students to have that connectivity for their self-directed digital learning activities. Just as researchers have noted that educators lack an appreciation for the value of students' self-directed, interest-driven digital learning ((Bowers & Berland, 2012; Grant, 2011; Greenhow & Robelia, 2009a; Ito, 2010; Lai, Khaddage, & Knezek, 2013), it appears that policy makers may hold that same sentiment. The results of this study and in particular the new findings about how students are using digital tools outside of school to self-remediate in math, to develop new skills for workplace readiness, and to explore what they need to prepare for future jobs and college, should open the door to including self-directed learning as a motivation for addressing the Homework Gap as an equity issue.

Students' use of digital tools to self-direct learning because of what they perceive as deficiencies in their current in-school learning experiences supports the work of Wagner (2008). In particular, Wagner extends the social justice and educational equity argument beyond simple digital connectivity. As he explains, even our nation's best schools continue to focus on old world school tasks and paradigms that do not address the development of the types of skills that students will need to thrive and compete in the global information economy and society. Thus, the *Global Achievement Gap*, as Wagner terms it, is increasingly less about resource disparity in our schools, and more about a mismatch between what students are learning and what they will need for post-school success. The increasing importance of this issue transcends community type and family socio-economic indicators.

The research and policy discussions on the *Second Level Digital Divide* and the *Homework Gap* highlight that students, particularly those in underserved communities and schools, often have to negotiate barriers and obstacles both at home and at school to use digital tools in ways that were relevant and meaningful for their lives and interests. Wagner’s *Global Achievement Gap* broadens the conversation beyond connectivity to a new issue of equity and social justice; how well are we preparing all of our students to compete in the increasingly information-intensive global economy and society. The new equity equation therefore means that policymakers as well as educators need to think beyond the old paradigms of schooling outcomes and realize that today’s students need a new set of skills to be successful. Equity is not just about access anymore, but increasingly about usage and the quality of the digital learning experience for all students, no matter what purpose is driving their learning needs and desires, or who is originating that learning process.

Researchers. As would be expected with a research study of this magnitude and in a developing field such as self-directed digital learning, several new areas for further research emerged from this study. One such research topic is shared here to inform the efforts of potential researchers interested in extending the findings from this study. The study provided new insights into how middle school students are using digital tools, content and resources to self-direct learning in purposeful ways outside of school. The analysis included a comprehensive evaluation of differences in self-directed learning behaviors based on students' gender, home Internet access, technology skill self-assessment and interest in a STEM career field. The results indicated statistically significant difference based upon these student characteristics or assets but the effect size (or practical significance) was small. Additionally new findings emerged that identified four primary purposes driving students' self-directed learning activities within a free agent learner ecosystem.

To further understand the learning behaviors and motivations of students using digital tools outside of school, additional research is needed on the impact of specific in-school digital learning experiences on the free agent learner ecosystem. For example, as schools expand the use of digital textbooks and mobile devices in the classroom, it would be valuable to know if those school-based experiences increase the frequency of students' self-directed digital learning outside of school, or if the students' purposes for those activities change as well. Additionally, as students gain more opportunities to participate in virtual classes, blended learning environments or flipped classroom models, it would be interesting to see if those environments where out of school digital learning is expected and encouraged results in an increase in free agent learning. A longitudinal study that examined the change in students' interests in self-directed learning over time with increasing exposure to more sophisticated uses of technology in their school day may help educators see increased value in supporting new classroom models and recognizing the benefits of students' out of school digitally rich learning lives. Ultimately, new research such as proposed here should aim to identify the interventions that are most successful in closing the gap between students' perceptions of the value of their self-directed digital learning lives that happen beyond the classroom, and their perceptions that their school does not "look like the world in which they live" (Spires, Lee, Turner & Johnson, 2008, p.510).

"I want to be a writer so I use Pinterest for my creative writing. I also use google and I have a tablet so therefore I can access these things. If I had these things in school I could be more creative and be more inspired by fellow writers."

7th grade "Free Agent Learner" from Nevada

APPENDIX A: SPEAK UP 2014 SURVEY QUESTIONNAIRE

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1.) What grade are you in?
- Grade 6
- Grade 7
- Grade 8

2.) Gender
- Girl
- Boy

3.) How would you rate your technology skills compared to other students in your class?
- Advanced – I know more than others
- Average - I know about the same as others
- Beginner - I am still learning how to use technology

4.) What class format best represents the majority of your classes this year?
- Traditional classroom - teacher and students together is a physical classroom
- Blended learning class where part of the time I am in an online learning environment and other times I am in a traditional face-to-face class away from home (like a school)
- Flipped class where students watch/listen to lectures or lessons at home and then use class time to do projects and get homework help
- Virtual class where my learning is done fully online
- Other

5.) Which of these things do you regularly do using technology for schoolwork? (Check all that apply)

Use a school portal for information like grades or to upload homework
Post to class blogs or class discussion board
Use online textbooks
Take tests or quizzes online
Use educational mobile apps (like graphing calculator, language translator, vocabulary lists)
Use Internet-based services (like Google drive, Dropbox, Turnitin.com)
Create presentations
Take photos of school assignments or textbook pages
Text message other students for class or homework help
Text message my teacher with class or homework related questions
Use email to communicate with my teachers
Use my social networking sites to work with classmates on a project (like Facebook, Twitter)
Find online video lessons to help with homework/studying (like YouTube, Kahn Academy)
Watch an online video created by my teacher
Listen to an audio recording or audio book
Use digital study games (like Quizlet, Coolmath.com)
Post content I create online (like writings, videos, artwork)

6.) What obstacles do you face using technology at your school? (Check all that apply)

Cannot use the school Internet with my mobile device
Not allowed to go on social media (like Twitter or Facebook)
Not allowed to text message with classmates
Not allowed to use any of my mobile devices on campus
Not enough computers or they don't often work
I cannot get online when I am at school
Websites that I need for schoolwork are blocked (through school filters or firewalls)
Internet speed is too slow
Teachers don't know how to use the technology
Teachers limit our technology use
Too many rules against using technology
Too much fear about the dangers of the Internet
Concerns about how my school is protecting my personal data
Technology is not needed to complete my assignments
I rarely use technology at my school
No obstacles

7.) How often do school filters or firewalls block you from using websites that you want to use for schoolwork assignments or projects?

Likert Scale: Frequency

- Never
- Rarely
- Sometimes
- Often
- All of the time

8.) Which of these mobile devices do you have for your own use (but not provided to you by your school)? (Check all that apply)

A phone with no internet
A Smartphone with internet (like iPhone, Samsung Galaxy)
Laptop
2-in-1 laptop (a laptop that can turn into a tablet)
Web-based laptop (like a Chromebook)
Tablet (like an iPad)
Digital reader (like Kindle or Nook)

9.) What kind of Internet access do you have at home? (Check all that apply)

- A slow Internet connection (like dialup through a landline)
- A fast Internet connection (like DSL, Broadband, or cable)
- A Wi-Fi connection
- A mobile data plan (like 3G/4G/LTE)
- No home access. I use free internet (like the public library, after school program or wifi hotspot)

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www.tomorrow.org

10.) Imagine that you were going to design the ideal mobile app for your class or school. What types of features or functionality should your mobile app have? (Check all that apply)

- Interactive school calendar
- Class schedule organizer
- Sports schedules and scores
- School information (like contact information, student handbook)
- School newsfeed
- Emergency alerts (like school closures)
- Notifications (like upcoming tests or due dates)
- Student portal to access grades and assignments
- Interactive forms for parents (report absences, permission slips)
- Parent portal (PTA information)
- School payment system
- Lunch menus
- Ability to connect with teachers
- Class group messages
- Tip line to report concerns (like bullying, cheating)
- Mental health/crisis hotline
- Links to school social media accounts
- Study games or apps
- Photo gallery
- Book list
- Other

11.) How important do you think it is for every student to be able to use a mobile device like a laptop, tablet or Chromebook during the school day to support schoolwork?
Likert Scale: Importance

- Very unimportant
- Unimportant
- Neither important nor unimportant
- Important
- Very important

12.) Which of these are true for you most of the time when you are at school? (Check all that apply)

- I use my own cell phone or smartphone in class to help with schoolwork
- I use a laptop in class that is provided by my school
- I use a tablet in class that is provided by my school
- I use a Chromebook in class that is provided by my school
- I use computers in the computer lab, library or media center to help with schoolwork
- I do not regularly use technology when I am at school

13.) What would be the BEST device to use for each of these schoolwork tasks?
Likert: Devices

- Smartphone
- Laptop
- Tablet
- Digital Reader

Options:

Write a report
Take notes
Take an online test
Create a PowerPoint
Create a video
Access an online textbook
Research online
Read online articles
Check grades
Watch a video (YouTube)
Take an online class
Connect with classmates
Connect with teachers
Collaborate on a school project
Access social media

14.) If you could take a fully online or virtual class in any school subject, what subjects would you like to take online? (Check all that apply)

Career Technical Education classes
Computer Science / Programming
Digital media production
English/Language Arts
Health
Journalism or Yearbook
Math
Physical Education
Science
Social Studies/History
Visual or performing arts
World or foreign languages
All of my classes
None of my classes
I have already taken an online class in one or more of these subjects

15.) **How important do you think it is for every student to take a fully online or virtual class before graduating from high school?**
Likert Scale: Importance
- Very unimportant
- Unimportant
- Neither important nor unimportant
- Important
- Very important

16.) In some schools, teachers have set up blended learning classrooms. In those classrooms, students spend part of the class week in a regular teacher led class at a school and the rest of the week the students are using online content with some level of control over the time, place, path, and/or pace of learning. Do you think that this would be a good way for you to learn?
- Yes
- No

17.) Many people around the world are interested in having more students pursue careers in science, technology, math or engineering. Are you interested in a job or career in any of these fields?
Likert Scale: Interest
- Not at all interested
- Somewhat uninterested
- Neither interested nor uninterested
- Somewhat interested
- Very interested

18.) How would you like to explore future careers or get prepared for a future job? (Check all that apply)

Go to an after school program
Go on field trips to companies and meet successful people
Learn about careers through social media like Twitter and Facebook
Learn from teachers that have worked in that type of job
Let career professionals teach lessons at school
Play an online or video game to learn more about a career
Take a quiz to find out my career interests or strengths
Learn about different jobs through "Day in the Life" videos
Use mobile apps or websites to explore careers
Participate in science and math competitions
Work with mentors who can help me with planning my future
Go to a summer camp (like space camp)
Use technology tools to make things (like 3D printers and maker software)

19.) **If your school offered a class or after school activity to learn how to program or code, how interested would you be in taking that class or participating in that activity?**
Likert Scale: Interest
- Not at all interested
- Somewhat interested
- Neither interested nor uninterested
- Somewhat interested
- Very interested
- Already doing that

20.) How often do you access these social media tools or online activities in your free time (not for schoolwork)?
Likert Scale: Interest
- Never
- Rarely
- Sometimes
- Often
- All of the time

Options:

Facebook
Instagram
Pinterest
Snapchat
Tumblr
Twitter
Vine
YouTube
Social messaging apps (like Facebook messenger, WhatsApp, KIK)
Video messaging (like Skype, FaceTime)
Blogging sites (your own or others)
Stream TV/movies (like Hulu, Netflix)
Online games/apps (like Quiz Up, Candy Crush)
Massively multiplayer online games (MMOG, MMORPG)
Special interest forums (like for games)

21.) What would be the benefits of having video, online, or digital games as a part of your regular schoolwork or classroom activities? (Check all that apply)

Games would make it easier to understand difficult topics
I would be a better thinker and problem solver
I would be more interested in the subject
I would feel more challenged in my schoolwork
I would get immediate feedback on how much I had learned
It would be a more interesting way to practice problems
I would try new things beyond what was assigned through the game
I would learn how to work in teams
I would learn more about the subject
I would be charge of my learning
Schoolwork could be personalized to my learning style
Games could adapt to what I know and make it harder or easier for me
Games would help show how I would use the topic in the real world
I would learn skills that I can use when I'm older
School would be more fun
I don't think I would like playing games in school

22.) Read these sentences. Check the box if you agree with them. As a result of using technology to support my learning...

I work together with my classmates more often
I talk with my teacher more often
I participate more in class discussions
I am developing critical thinking and problem solving skills
I am developing creativity skills
I gain a better understanding of the class materials
I spend more time mastering a skill or learning something
I am able to learn at my own pace
I have more control over my learning
I am learning in a way that better fits my learning style
I am more interested in what I am learning in class
My test scores and grades are better
I am more likely to complete homework assignments
My learning does not stop at the end of the class period or school day

23.) How often do you engage in the following activities because you want to learn a skill or know more about something educational that interests you (but not just because it was an assignment or homework)?

Likert Scale: Frequency

- Never
- Rarely
- Sometimes
- Often
- All of the time

Options:

Research a website to learn more on a topic
Read an online news story or report
Watch a video to learn how to do something
Watch a TedTalk or similar short videos about people's ideas
Post a question on a discussion board or forum
Use social media to identify people who share my interests
Use social media to learn what others are doing or thinking about a topic that interests me
Find experts online to answer my questions
Took a self-paced tutorial or online class
Play an online game or virtual simulation activity
Use online writing tools to improve my writing

24.) Imagine you are designing your dream school. Which of these tools would have the greatest positive impact on your learning? (Check all that apply)

- Internet access anywhere at school
- Freedom to use my own mobile devices
- School provides every student with a mobile device
- Mobile device accessories (like attachable keyboards, covers)
- Things like databases, digital books, animations, and videos to help with schoolwork
- Digital games or virtual simulations
- Software that changes the level of difficulty and content to match your needs
- "Digital backpack" to help organize your work and access important information (like take notes, organize, and view assignments)
- Mobile apps for learning
- Interactive whiteboards (like Smartboard, Polyvision)
- Learning management systems (like Blackboard)
- A handheld device to answer questions in class (like clickers)
- 3D printer
- Digital reader (like Kindle, Nook)
- Digital media creation tools (like video, audio)
- School mobile app
- Online or virtual classes
- Online tests and assessments
- Online textbooks
- Online tutors
- Social media tools to connect and work with others (like blogs, wikis, social networking sites)
- Text messaging
- Google hangouts or other online group messaging in class
- Other

25.) How much do you agree with these statements?
Likert Scale: Agreement
- Strongly disagree
- Disagree
- Neither agree nor disagree
- Agree
- Strongly agree

Options:
There is at least one adult at school that I can talk to about school or personal problems
I believe that my school cares about me as a person
Teachers are important to my learning
Doing well in school is important to me
I am interested in what I am learning at school
Using technology in my classes increases my engagement in learning
I like learning how to do things
I like learning about new ideas
I wish my classes were more interesting
I would learn more if my classes used more technology to support my learning
I am learning important things for my future on my own outside of school
I like learning when I can be in control of when and how I learn
The subjects that I am learning at school are important for my future
The skills that I am learning at school are important for my future
I am often bored in my classes at school
I don't like school

26.) Which of these have been problems for other students at your school? (Check all that apply)
Approached by strangers online
Sharing too much personal information online
Seeing websites with inappropriate content
Students using others' ideas as their own (like plagiarism)
Being harassed online with hurtful texts or photos
Sharing suggestive texts or photos
Strangers asking to meet in person
Spending too much time online
Students using mobile devices to cheat
Students' mobile devices have been stolen
Students using their mobile devices in class when it is not allowed or appropriate
Students' personal school data has been shared without their permission

27.) Has your school explained to you how they are protecting the confidentiality of your personal school data that is stored digitally (grades, test scores, discipline records, etc)?
- Yes
- No

28.) Some students are using social media tools, videos, and online games outside of school to explore or teach themselves about academic or school topics that interest them. How are you using technology outside of school to learn new things or skills? Tell us what you are learning about and the types of digital tools or resources that you are using.

29.) Pick a school subject and tell us how using technology in that class could make that subject more interesting for you. Some things to think about for your response: what type of class would it be, what type of technology would you like to use, and how would that technology help you learn more.

30.) Are you participating in any of these programs at your school this year? (Check all that apply)

AVID (Advancement Via Individual Determination)
Computer program club (coding)
Future Teacher Academies
Gear UP
IB (International Baccalaureate)
JROTC (Junior Reserve Officer Training Corps)
MUN (Model United Nations) or Model Congress
School Video Production Team
STEM (Science, Technology, Engineering, and Mathematics) Academies
Student Government
Student Tech Support Team
Visual and Performing Arts Academies
None of the above

APPENDIX B: PROJECT TOMORROW PERMISSION TO USE SPEAK UP DATA FORM

Permission to Use Speak Up Data

Organization Name	Julie Evans				
Contact:					
Mailing Address					
City		**State**		**Zip**	
Email address	jevans@tomorrow.org	**Phone**			
Speak Up Years	2014	**Usage**	For dissertation		
When will data be published:	2016				

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Julie Evans
Chief Executive Officer

Date Permission Granted: August 1, 2015

APPENDIX C: DESCRIPTIVE STATISTICS

Table C.1 Analysis of the strength and direction of relationships between the various self-directed digital learning behaviors

		LB #1	LB #2	LB #3	LB #4	LB #5	LB #6	LB #7	LB #8
LB #1	Pearson Correlation	1	.441	.292	.254	.288	.322	.278	.343
	Sig. (2-tailed)		.000	.000	.000	.000	.000	.000	.000
	N	107960	104600	104412	104981	104533	104409	104195	104033
LB #2	Pearson Correlation		1	.257	.329	.351	.309	.376	.283
	Sig. (2-tailed)			.000	.000	.000	.000	.000	.000
	N		105766	102780	103287	102845	102708	102514	102307
LB #3	Pearson Correlation			1	.451	.429	.469	.308	.425
	Sig. (2-tailed)				.000	.000	.000	.000	.000
	N			105271	103817	103408	103279	102902	102861
LB #4	Pearson Correlation				1	.764	.433	.316	.328
	Sig. (2-tailed)					.000	.000	.000	.000
	N				106002	104145	103987	103625	103488
LB #5	Pearson Correlation					1	.447	.329	.339
	Sig. (2-tailed)						.000	.000	.000
	N					105460	103735	103325	103272
LB #6	Pearson Correlation						1	.353	.412
	Sig. (2-tailed)							.000	.000
	N						105341	103411	103349
LB #7	Pearson Correlation							1	.374
	Sig. (2-tailed)								.000
	N							105233	103284
LB #8	Pearson Correlation								1
	Sig. (2-tailed)								
	N								104912

Table C.2 Group statistics for self-directed digital learning behaviors with gender as the variable

	Gender	N	Mean	Std. Deviation	Std. Error Mean
LB #1	girl	53744	2.9582	1.10618	.00477
	boy	53680	2.8717	1.13550	.00490
LB #2	girl	52724	3.3250	1.14113	.00497
	boy	52516	3.2634	1.15763	.00505
LB #3	girl	52615	1.7375	1.06866	.00466
	boy	52131	1.8234	1.12420	.00492
LB #4	girl	52943	2.2984	1.39304	.00605
	boy	52532	2.1053	1.29415	.00565
LB #5	girl	52723	2.3986	1.38925	.00605
	boy	52222	2.1762	1.29601	.00567
LB #6	girl	52681	1.9796	1.19859	.00522
	boy	52143	2.0494	1.22357	.00536
LB #7	girl	52409	2.5859	1.30850	.00572
	boy	52313	2.8835	1.33759	.00585
LB #8	girl	52588	2.2596	1.29916	.00567
	boy	51812	2.1154	1.24979	.00549

Table C.3 Means comparison for self-directed learning behaviors with gender as the variable

		Levene's Test for Equality of Variances		t-test for Equality of Means						
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
									Lower	Upper
LB 1	Equal variances assumed	158.605	.000	12.653	107422	.000	.08654	.00684	.07314	.09995
	Equal variances not assumed			12.652	107341.682	.000	.08654	.00684	.07314	.09995
LB 2	Equal variances assumed	.082	.775	8.694	105238	.000	.06161	.00709	.04772	.07550
	Equal variances not assumed			8.694	105202.745	.000	.06161	.00709	.04772	.07550
LB 3	Equal variances assumed	170.383	.000	-12.678	104744	.000	-.08592	.00678	-.09920	-.07263
	Equal variances not assumed			-12.675	104370.169	.000	-.08592	.00678	-.09920	-.07263

Table C.3 Continued

		Levene's Test for Equality of Variances		t-test for Equality of Means						
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
									Lower	Upper
LB 4	Equal variances assumed	828.030	.000	23.317	105473	.000	.19309	.00828	.17686	.20932
	Equal variances not assumed			23.324	105019.267	.000	.19309	.00828	.17686	.20932
LB 5	Equal variances assumed	697.103	.000	26.810	104943	.000	.22240	.00830	.20614	.23866
	Equal variances not assumed			26.819	104568.570	.000	.22240	.00829	.20615	.23866
LB 6	Equal variances assumed	73.971	.000	-9.339	104822	.000	-.06987	.00748	-.08453	-.05520
	Equal variances not assumed			-9.338	104722.069	.000	-.06987	.00748	-.08453	-.05520
LB 7	Equal variances assumed	17.910	.000	-36.403	104720	.000	-.29767	.00818	-.31370	-.28165
	Equal variances not assumed			-36.402	104660.655	.000	-.29767	.00818	-.31370	-.28165
LB 8	Equal variances assumed	280.445	.000	18.268	104398	.000	.14417	.00789	.12870	.15963
	Equal variances not assumed			18.274	104338.561	.000	.14417	.00789	.12870	.15963

Table C.4 Effect size testing results for the self-directed learning behaviors with gender as the variable

Self-directed behavior	*Cohen's d*
Research a website	0.077168
Watch a video to learn how to do something	0.053593
Post question on discussion board	-0.07833
Use social media to identify people	0.143601
Use social media to learn what others are thinking/doing	0.165518
Find experts online	-0.05763
Play online game	-0.22492
Use online writing tools	0.113107

Table C.5 Group statistics for self-directed digital learning behaviors with Internet connectivity at home as the variable

Home Internet connectivity		N	Mean	Std. Deviation	Std. Error Mean
LB #1	high speed internet	8539	2.9115	1.14590	.01240
	all others	28660	2.8600	1.11182	.00657
LB #2	high speed internet	8326	3.2465	1.17339	.01286
	all others	28035	3.2035	1.14237	.00682
LB #3	high speed internet	8238	1.8371	1.12976	.01245
	all others	27880	1.7213	1.06193	.00636
LB #4	high speed internet	8327	2.0986	1.31658	.01443
	all others	28036	2.0438	1.28568	.00768
LB #5	high speed internet	8261	2.1614	1.30856	.01440
	all others	27881	2.1280	1.28801	.00771
LB #6	high speed internet	8254	2.0396	1.22922	.01353
	all others	27886	1.9305	1.17279	.00702
LB #7	high speed internet	8262	2.7561	1.35893	.01495
	all others	27849	2.6372	1.30671	.00783
LB #8	high speed internet	8201	2.1885	1.27234	.01405
	all others	27762	2.1268	1.25065	.00751

Table C.6 Means comparison for self-directed learning behaviors with Internet connectivity at home as the variable

		Levene's Test for Equality of Variances		t-test for Equality of Means						
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
									Lower	Upper
LB 1	Equal variances assumed	5.576	.018	3.727	37197	.000	.05145	.01381	.02439	.07851
	Equal variances not assumed			3.667	13678.617	.000	.05145	.01403	.02395	.07896
LB 2	Equal variances assumed	20.039	.000	2.992	36359	.003	.04293	.01435	.01480	.07105
	Equal variances not assumed			2.949	13357.161	.003	.04293	.01456	.01439	.07146
LB 3	Equal variances assumed	55.628	.000	8.570	36116	.000	.11583	.01352	.08934	.14232
	Equal variances not assumed			8.286	12840.590	.000	.11583	.01398	.08843	.14323

Table C.6 Continued

		Levene's Test for Equality of Variances		t-test for Equality of Means						
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
									Lower	Upper
LB 4	Equal variances assumed	23.884	.000	3.398	36361	.001	.05483	.01613	.02320	.08645
	Equal variances not assumed			3.355	13391.331	.001	.05483	.01634	.02279	.08687
LB 5	Equal variances assumed	8.926	.003	2.060	36140	.039	.03335	.01619	.00161	.06509
	Equal variances not assumed			2.042	13356.812	.041	.03335	.01633	.00134	.06537
LB 6	Equal variances assumed	34.301	.000	7.345	36138	.000	.10915	.01486	.08002	.13828
	Equal variances not assumed			7.160	13019.801	.000	.10915	.01524	.07927	.13903
LB 7	Equal variances assumed	18.591	.000	7.200	36109	.000	.11896	.01652	.08658	.15135
	Equal variances not assumed			7.049	13121.840	.000	.11896	.01688	.08588	.15204
LB 8	Equal variances assumed	11.348	.001	3.911	35961	.000	.06172	.01578	.03079	.09265
	Equal variances not assumed			3.875	13230.498	.000	.06172	.01593	.03050	.09294

Table C.7 Effect size testing results for the self-directed learning behaviors with Internet connectivity at home as the variable

Self-directed behavior	*Cohen's d*
Research a website	0.045993
Watch a video to learn how to do something	0.037406
Post question on discussion board	0.1025
Use social media to identify people	0.042388
Use social media to learn what others are thinking/doing	0.025837
Find experts online	0.091997
Play online game	0.090155
Use online writing tools	0.049139

Table C.8 Group statistics for self-directed digital learning behaviors with technology skill self-assessment as the variable

Technology skill self-assessment		N	Mean	Std. Deviation	Std. Error Mean
LB #1	advanced	29615	3.0887	1.17395	.00682
	average + beginner	77752	2.8494	1.09400	.00392
LB #2	advanced	28973	3.5195	1.16862	.00687
	average + beginner	76224	3.2084	1.13058	.00410
LB #3	advanced	28946	1.9448	1.20448	.00708
	average + beginner	75766	1.7177	1.04712	.00380
LB #4	advanced	29129	2.3858	1.44379	.00846
	average + beginner	76309	2.1329	1.30346	.00472
LB #5	advanced	28991	2.4721	1.44160	.00847
	average + beginner	75908	2.2186	1.30437	.00473
LB #6	advanced	28931	2.1896	1.30740	.00769
	average + beginner	75840	1.9470	1.16588	.00423
LB #7	advanced	28987	3.0527	1.39230	.00818
	average + beginner	75682	2.6129	1.28637	.00468
LB #8	advanced	28801	2.3217	1.36449	.00804
	average + beginner	75551	2.1372	1.23877	.00451

Table C.9 Means comparison for self-directed learning behaviors with technology skill self-assessment as the variable

		Levene's Test for Equality of Variances		t-test for Equality of Means						
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
									Lower	Upper
LB 1	Equal variances assumed	166.213	.000	31.383	107365	.000	.23929	.00762	.22435	.25424
	Equal variances not assumed			30.408	50347.376	.000	.23929	.00787	.22387	.25472
LB 2	Equal variances assumed	230.307	.000	39.506	105195	.000	.31116	.00788	.29572	.32660
	Equal variances not assumed			38.924	50808.760	.000	.31116	.00799	.29549	.32683
LB 3	Equal variances assumed	784.264	.000	30.064	104710	.000	.22704	.00755	.21224	.24184

Table C.9 Continued

		Levene's Test for Equality of Variances		t-test for Equality of Means						
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
									Lower	Upper
	Equal variances not assumed			28.249	46589.566	.000	.22704	.00804	.21128	.24279
LB 4	Equal variances assumed	1300.045	.000	27.327	105436	.000	.25290	.00925	.23476	.27104
	Equal variances not assumed			26.109	48288.326	.000	.25290	.00969	.23391	.27188
LB 5	Equal variances assumed	1165.957	.000	27.322	104897	.000	.25347	.00928	.23529	.27165
	Equal variances not assumed			26.130	48154.869	.000	.25347	.00970	.23446	.27248
LB 6	Equal variances assumed	1131.710	.000	29.095	104769	.000	.24259	.00834	.22625	.25893
	Equal variances not assumed			27.645	47478.005	.000	.24259	.00878	.22539	.25979
LB 7	Equal variances assumed	141.316	.000	48.367	104667	.000	.43985	.00909	.42202	.45767
	Equal variances not assumed			46.692	49030.690	.000	.43985	.00942	.42138	.45831
LB 8	Equal variances assumed	973.430	.000	20.894	104350	.000	.18445	.00883	.16714	.20175
	Equal variances not assumed			20.011	47937.348	.000	.18445	.00922	.16638	.20251

Table C.10 Effect size testing results for the self-directed learning behaviors with technology skill self-assessment as the variable

Self-directed behavior	*Cohen's d*
Research a website	0.214307
Watch a video to learn how to do something	0.272612
Post question on discussion board	0.207798
Use social media to identify people	0.188213
Use social media to learn what others are thinking/doing	0.188658
Find experts online	0.201058
Play online game	0.334053
Use online writing tools	0.144739

Table C.11 Group statistics for self-directed digital learning behaviors with STEM interest as the variable

	STEM career field interest	N	Mean	Std. Deviation	Std. Error Mean
LB #1	interested	65055	3.0265	1.09944	.00431
	not interested	38384	2.7253	1.12768	.00576
LB #2	interested	63853	3.3874	1.12073	.00444
	not interested	37508	3.1427	1.17535	.00607
LB #3	interested	63582	1.8059	1.11179	.00441
	not interested	37315	1.7194	1.05928	.00548
LB #4	interested	63972	2.1834	1.34929	.00533
	not interested	37634	2.2288	1.34520	.00693
LB #5	interested	63672	2.2824	1.35123	.00535
	not interested	37426	2.2910	1.34138	.00693
LB #6	interested	63621	2.0516	1.23138	.00488
	not interested	37366	1.9291	1.16281	.00602
LB #7	interested	63630	2.8411	1.33192	.00528
	not interested	37251	2.5443	1.30586	.00677
LB #8	interested	63448	2.2408	1.29301	.00513
	not interested	37135	2.0820	1.23734	.00642

Table C.12 Means comparison for self-directed learning behaviors with STEM interest as the variable

		Levene's Test for Equality of Variances		t-test for Equality of Means						
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
									Lower	Upper
LB 1	Equal variances assumed	536.543	.000	42.166	103437	.000	.30124	.00714	.28724	.31524
	Equal variances not assumed			41.891	78872.295	.000	.30124	.00719	.28715	.31533
LB 2	Equal variances assumed	.789	.375	32.958	101359	.000	.24469	.00742	.23014	.25925
	Equal variances not assumed			32.553	75602.096	.000	.24469	.00752	.22996	.25943
LB 3	Equal variances assumed	105.526	.000	12.148	100895	.000	.08656	.00713	.07259	.10052
	Equal variances not assumed			12.301	81231.790	.000	.08656	.00704	.07277	.10035

Table C.12 Continued

		Levene's Test for Equality of Variances		t-test for Equality of Means						
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
									Lower	Upper
LB 4	Equal variances assumed	.077	.782	-5.190	101604	.000	-.04544	.00876	-.06260	-.02828
	Equal variances not assumed			-5.194	79069.279	.000	-.04544	.00875	-.06259	-.02830
LB 5	Equal variances assumed	8.423	.004	-.982	101096	.326	-.00862	.00878	-.02582	.00858
	Equal variances not assumed			-.984	78887.596	.325	-.00862	.00876	-.02579	.00855
LB 6	Equal variances assumed	213.135	.000	15.579	100985	.000	.12251	.00786	.10709	.13792
	Equal variances not assumed			15.813	81921.810	.000	.12251	.00775	.10732	.13769
LB 7	Equal variances assumed	7.212	.007	34.406	100879	.000	.29682	.00863	.27991	.31372
	Equal variances not assumed			34.584	79233.937	.000	.29682	.00858	.27999	.31364
LB 8	Equal variances assumed	311.381	.000	19.103	100581	.000	.15886	.00832	.14256	.17515
	Equal variances not assumed			19.324	80519.689	.000	.15886	.00822	.14274	.17497

Table C.13 Effect size testing results for the self-directed learning behaviors with STEM interest as the variable

Self-directed behavior	*Cohen's d*
Research a website	0.271991
Watch a video to learn how to do something	0.214415
Post question on discussion board	0.079164
Use social media to identify people	-0.03369
Use social media to learn what others are thinking/doing	-0.00638
Find experts online	0.101536
Play online game	0.224448
Use online writing tools	0.12477

Table C.14 Descriptive statistics for the attitude statements about learning

Attitude statement about learning	N	Mean	Std. Deviation	Skewness		Kurtosis	
	Statistic	Statistic	Statistic	Statistic	Std. Error	Statistic	Std. Error
I like learning how to do things	105338	3.9206	.95206	-.974	.008	1.034	.015
I like learning about new ideas	104863	3.8638	.97617	-.895	.008	.742	.015
I am learning important things for my future on my own outside of school	104894	3.6353	1.08369	-.645	.008	-.084	.015
I like learning when I can be in control of when and how I learn	104457	3.7775	1.05709	-.741	.008	.117	.015

Table C.15 Analysis of the strength and direction of relationships between self-directed digital learning behaviors and attitudes statements about learning

		Learning to do things	Learning about new ideas	Learning outside of school	Learning when in control
LB #1	Pearson Correlation	.257	.279	.212	.170
	Sig. (2-tailed)	0.000	0.000	0.000	0.000
	N	102508	102006	102151	101742
LB #2	Pearson Correlation	.249	.236	.177	.196
	Sig. (2-tailed)	0.000	0.000	0.000	0.000
	N	100856	100382	100503	100088
LB #3	Pearson Correlation	.055	.078	.093	.079
	Sig. (2-tailed)	.000	.000	.000	.000
	N	100759	100283	100519	100121
LB #4	Pearson Correlation	.050	.064	.074	.123
	Sig. (2-tailed)	.000	.000	.000	0.000
	N	101417	100982	101177	100801
LB #5	Pearson Correlation	.081	.096	.098	.138
	Sig. (2-tailed)	.000	.000	.000	0.000
	N	101082	100620	100875	100475
LB #6	Pearson Correlation	.087	.105	.115	.103
	Sig. (2-tailed)	.000	.000	.000	.000
	N	101013	100563	100796	100429
LB #7	Pearson Correlation	.143	.142	.134	.165
	Sig. (2-tailed)	0.000	0.000	0.000	0.000
	N	100949	100493	100740	100351
LB #8	Pearson Correlation	.134	.160	.149	.118
	Sig. (2-tailed)	0.000	0.000	0.000	0.000
	N	100755	100276	100540	100156

Table C.16 Group statistics for self-directed digital learning behaviors with the outcome value of collaboration with classmates as the variable

	I work together with my classmates more often	N	Mean	Std. Deviation	Std. Error Mean
LB #1	Selected	62831	3.0072	1.11345	.00444
	Not selected	45129	2.7868	1.12154	.00528
LB #2	Selected	61553	3.4041	1.13275	.00457
	Not selected	44213	3.1410	1.15602	.00550
LB #3	Selected	61301	1.8609	1.13344	.00458
	Not selected	43970	1.6698	1.03671	.00494
LB #4	Selected	61758	2.3300	1.38043	.00555
	Not selected	44244	2.0247	1.28122	.00609
LB #5	Selected	61486	2.4232	1.37425	.00554
	Not selected	43974	2.1002	1.28821	.00614
LB #6	Selected	61418	2.1160	1.24655	.00503
	Not selected	43923	1.8732	1.14686	.00547
LB #7	Selected	61363	2.8581	1.34124	.00541
	Not selected	43870	2.5614	1.29812	.00620
LB #8	Selected	61244	2.2895	1.30022	.00525
	Not selected	43668	2.0473	1.23110	.00589

Table C.17 Means comparison for self-directed learning behaviors with the outcome value of collaboration with classmates as the variable

		Levene's Test for Equality of Variances		t-test for Equality of Means						
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
									Lower	Upper
LB 1	Equal variances assumed	315.070	.000	31.987	107958	.000	.22044	.00689	.20693	.23394
	Equal variances not assumed			31.949	96796.395	.000	.22044	.00690	.20691	.23396
LB 2	Equal variances assumed	41.038	.000	36.941	105764	.000	.26312	.00712	.24916	.27708
	Equal variances not assumed			36.818	94081.586	.000	.26312	.00715	.24911	.27712
LB 3	Equal variances assumed	475.391	.000	27.957	105269	.000	.19115	.00684	.17775	.20455
	Equal variances not assumed			28.369	99318.585	.000	.19115	.00674	.17794	.20436

Table C.17 Continued

		Levene's Test for Equality of Variances		t-test for Equality of Means						
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
									Lower	Upper
LB 4	Equal variances assumed	1116.829	.000	36.577	106000	.000	.30526	.00835	.28890	.32162
	Equal variances not assumed			37.030	99253.425	.000	.30526	.00824	.28910	.32142
LB 5	Equal variances assumed	747.866	.000	38.620	105458	0.000	.32297	.00836	.30658	.33936
	Equal variances not assumed			39.036	98172.033	0.000	.32297	.00827	.30676	.33919
LB 6	Equal variances assumed	577.612	.000	32.215	105339	.000	.24278	.00754	.22800	.25755
	Equal variances not assumed			32.663	98969.384	.000	.24278	.00743	.22821	.25734
LB 7	Equal variances assumed	.011	.916	35.861	105231	.000	.29673	.00827	.28051	.31295
	Equal variances not assumed			36.056	96287.626	.000	.29673	.00823	.28060	.31286
LB 8	Equal variances assumed	616.998	.000	30.408	104910	.000	.24224	.00797	.22662	.25785
	Equal variances not assumed			30.687	96999.638	.000	.24224	.00789	.22676	.25771

Table C.18 Effect size testing results for the self-directed learning behaviors with the outcome value of collaboration with classmates as the variable

Self-directed behavior	*Cohen's d*
Research a website	0.197343
Watch a video to learn how to do something	0.230277
Post question on discussion board	0.174668
Use social media to identify people	0.227825
Use social media to learn what others are thinking/doing	0.241239
Find experts online	0.201329
Play online game	0.224189
Use online writing tools	0.190423

Table C.19 Analysis of the strength and direction of relationships between the various self-directed digital learning behaviors with data from students who want to use digital tools for career exploration (Cohort A)

		LB #1	LB #2	LB #3	LB #4	LB #5	LB #6	LB #7	LB #8
LB #1	Pearson Correlation	1	.537	.394	.373	.395	.438	.399	.427
	Sig. (2-tailed)		0.000	0.000	0.000	0.000	0.000	0.000	0.000
	N	9764	9494	9508	9574	9541	9524	9496	9469
LB #2	Pearson Correlation	.537	1	.329	.441	.463	.389	.485	.370
	Sig. (2-tailed)	0.000		.000	0.000	0.000	0.000	0.000	.000
	N	9494	9557	9338	9402	9372	9345	9322	9294
LB #3	Pearson Correlation	.394	.329	1	.491	.458	.551	.361	.497
	Sig. (2-tailed)	0.000	.000		0.000	0.000	0.000	.000	0.000
	N	9508	9338	9567	9452	9419	9400	9367	9343
LB #4	Pearson Correlation	.373	.441	.491	1	.791	.491	.411	.401
	Sig. (2-tailed)	0.000	0.000	0.000		0.000	0.000	0.000	0.000
	N	9574	9402	9452	9641	9504	9484	9446	9417
LB #5	Pearson Correlation	.395	.463	.458	.791	1	.504	.424	.397
	Sig. (2-tailed)	0.000	0.000	0.000	0.000		0.000	0.000	0.000
	N	9541	9372	9419	9504	9601	9461	9418	9396
LB #6	Pearson Correlation	.438	.389	.551	.491	.504	1	.436	.509
	Sig. (2-tailed)	0.000	0.000	0.000	0.000	0.000		0.000	0.000
	N	9524	9345	9400	9484	9461	9582	9413	9393
LB #7	Pearson Correlation	.399	.485	.361	.411	.424	.436	1	.467
	Sig. (2-tailed)	0.000	0.000	.000	0.000	0.000	0.000		0.000
	N	9496	9322	9367	9446	9418	9413	9564	9393
LB #8	Pearson Correlation	.427	.370	.497	.401	.397	.509	.467	1
	Sig. (2-tailed)	0.000	.000	0.000	0.000	0.000	0.000	0.000	
	N	9469	9294	9343	9417	9396	9393	9393	9525

Table C.20 Analysis of the strength and direction of relationships between the various self-directed digital learning behaviors with data from students who want to use traditional means for career exploration (Cohort B)

		LB #1	LB #2	LB #3	LB #4	LB #5	LB #6	LB #7	LB #8
LB #1	Pearson Correlation	1	.422	.268	.228	.264	.298	.254	.324
	Sig. (2-tailed)		0.000	0.000	0.000	0.000	0.000	0.000	0.000
	N	95302	92334	92165	92655	92254	92159	91970	91856
LB #2	Pearson Correlation	.422	1	.235	.304	.326	.288	.353	.263
	Sig. (2-tailed)	0.000		0.000	0.000	0.000	0.000	0.000	0.000
	N	92334	93381	90742	91177	90780	90682	90505	90348
LB #3	Pearson Correlation	.268	.235	1	.430	.410	.443	.287	.404
	Sig. (2-tailed)	0.000	0.000		0.000	0.000	0.000	0.000	0.000
	N	92165	90742	92919	91639	91278	91175	90833	90836
LB #4	Pearson Correlation	.228	.304	.430	1	.754	.408	.286	.303
	Sig. (2-tailed)	0.000	0.000	0.000		0.000	0.000	0.000	0.000
	N	92655	91177	91639	93554	91903	91774	91451	91366
LB #5	Pearson Correlation	.264	.326	.410	.754	1	.424	.299	.317
	Sig. (2-tailed)	0.000	0.000	0.000	0.000		0.000	0.000	0.000
	N	92254	90780	91278	91903	93073	91555	91187	91175
LB #6	Pearson Correlation	.298	.288	.443	.408	.424	1	.327	.387
	Sig. (2-tailed)	0.000	0.000	0.000	0.000	0.000		0.000	0.000
	N	92159	90682	91175	91774	91555	92980	91285	91253
LB #7	Pearson Correlation	.254	.353	.287	.286	.299	.327	1	.351
	Sig. (2-tailed)	0.000	0.000	0.000	0.000	0.000	0.000		0.000
	N	91970	90505	90833	91451	91187	91285	92884	91179
LB #8	Pearson Correlation	.324	.263	.404	.303	.317	.387	.351	1
	Sig. (2-tailed)	0.000	0.000	0.000	0.000	0.000	0.000	0.000	
	N	91856	90348	90836	91366	91175	91253	91179	92626

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