University of Montana
ScholarWorks at University of Montana

Graduate Student Theses, Dissertations, & Professional Papers

Graduate School

2018

INTELLIGENT PERSONAL ASSISTANTS IN THE CLASSROOM: IMPACT ON STUDENT ENGAGEMENT

Jason Patrick Neiffer

Let us know how access to this document benefits you.

Follow this and additional works at: https://scholarworks.umt.edu/etd

Recommended Citation

Neiffer, Jason Patrick, "INTELLIGENT PERSONAL ASSISTANTS IN THE CLASSROOM: IMPACT ON STUDENT ENGAGEMENT" (2018). *Graduate Student Theses, Dissertations, & Professional Papers*. 11241.
https://scholarworks.umt.edu/etd/11241

This Dissertation is brought to you for free and open access by the Graduate School at ScholarWorks at University of Montana. It has been accepted for inclusion in Graduate Student Theses, Dissertations, & Professional Papers by an authorized administrator of ScholarWorks at University of Montana. For more information, please contact scholarworks@mso.umt.edu.

INTELLIGENT PERSONAL ASSISTANTS IN THE CLASSROOM:

IMPACT ON STUDENT ENGAGEMENT

By

JASON PATRICK NEIFFER

M.Sc., Walden University, Minneapolis, MN, 2004
B.A., Carroll College, Helena, MT, 1997

Dissertation

presented in partial fulfillment of the requirements for the degree of

Doctor of Education
Teaching and Learning

The University of Montana
Missoula, Montana

12 May 2018

Approved by:

Dr. Scott Whittenburg, Dean of the Graduate School
Graduate School

Dr. Martin Horejsi, Chair
Teaching and Learning

Dr. David Erickson
Teaching and Learning

Dr. Roberta Evans
Educational Leadership

Dr. Patty Kero
Educational Leadership

Dr. Heidi Rogers
CEO, Northwest Council for Computer Education

© COPYRIGHT

By

Jason Patrick Neiffer

2018

All Rights Reserved

Abstract

Neiffer, Jason, P., Ed.D., Spring 2018 *Curriculum and Instruction*

Intelligent Personal Assistants in the Classroom: Impact on Student Engagement

Chairperson: Dr. Martin Horejsi

Intelligent personal assists are as a software tool utilized by millions of consumers to interact with their smartphone, tablet, laptop or desktop computer, or smart speaker. As more mobile and computer operating systems offer the feature, more classrooms and ultimately students will have access to one of these tools, either on a school-purchased device or a personal device.

The aim of this study was to look at a specific implementation of Siri, an intelligent personal assistant platform, in upper elementary and middle school science classrooms. The researcher utilized the lense of student engagement to measure the impact of the implementation of Siri.

To that end, the research proposed the research question: Does implementation of the intelligent personal assistant Siri via purposeful introduction and instruction increase engagement of middle school science students or upper elementary students?

The research question is answered utilizing a quasi-experimental model that measures engagement via the *Engagement Versus Disaffection with Learning-Student Report* instrument, pre- and post-treatment. The treatment involved teachers introducing Siri to treatment groups and then encouraging appropriate use. The researcher analyzed results utilizing descriptive statistics, paired-sample t-test, and the Wilcoxon Signed Rank test.

The researcher found only one statistically significant result out of 24 tests conducted. After analysis of changes in student use and student perception of engagement across all tests, along with an analysis of effect sizes, the research was not able to find persuasive evidence to reject the null hypothesis.

Dedication

This work is dedicated to…

My mom and dad, who responded to every one of my half-baked schemes, plans, adventures, and career changes with “that’s great!,” “you would be great at that!,” and “that sounds about right!”

Mrs. Platisha, my 5th grade teacher, who started me down the road of this project twenty-five years before Siri existed.

Sondra, Lynn, Susan, and ultimately Ryan, who conspired to keep me alive and vibrant despite nature having other plans.

Alison, for all of the above and everything else. A dedication to a dissertation is hardly enough but but I hope it is a start.

I love you all.

Acknowledgements

I would like to thank the following people for not only assisting in this project, but, also inspiring me in my twenty-year career in education. Convention suggests that this section be short and to the point, but, I did not get to this point in my career by following conventions… why start now?

First, to my committee;

Dr. David Erickson, for his mentoring in and out of the classroom, his eagle eye on APA- and IRB-related matters, and his world view in education that things are good… but we can always be better;

Dr. Bobbie Evans, for her persistent and positive advocacy for me personally and professionally; her role in connecting me with my work at Montana Digital Academy, and her energetic approach to everything;

Dr. Patty Kero, for her unwavering faith in me as a student and scholar; for expert guidance in the statistical portion of this study; and for her encouragement even when I felt overwhelmed;

Dr. Heidi Rogers, for her mentorship in all aspects of education; for her constant reminders that this process is about what I want it to be about, no one else; and for her insistence that we can always be positive advocates for ourselves and others; and of course,

Dr. Martin Horejsi, for insisting that I continue with this program, despite temptations to settle for less, for his outside-the-box thinking that inspired this topic, for advocating for me to take on a role at Montana Digital Academy, and ultimately for being the biggest dreamer I know in education; also to,

Nicole Rosenleaf Ritter, a long-time friend and former speech and debate teammate from high school, for her expert proofreading and editing assistance and positive cheering;

Erin O'Reilly, a PJWCOEHS classmate and co-worker, for her technical assistance and affirmation as a critical time in the writing process;

Dr. Anna Baldwin, my “cohort of two” partner-in-crime that managed to get out of this program in half the time, but, continued to push me in subtle and not-so-subtle ways to finish this up;

Other University of Montana professors that provided excellent coursework, positive encouragement in this process, including the chair of my comps committee, Dr. Darrell Stolle, along with Dr. Trent Atkins, Dr. Bill McCaw, and Dr. John Matt. I want to also thank the late Dr. Sally Brewer, who was responsible recruiting me for the this program at the University of Montana, along with Dr. Kate Brayko and Dr. Georgia Cobbs for being incredibly encouraging throughout;

The teachers and administrators at the nameless school where I completed the study; I hope they get an opportunity to read this and know that I enjoyed my time in their school and classrooms immensely;

Although I have had many partners-in-crime in my time in education, I want to specifically thank Don Pogreba, Jay Partridge, and Mike Agostinelli, who set standards of excellence that always kept the bar high for me and encouraged me to break rules when necessary;

To three particular bosses in my time in education, Kathy Lockyer, Barb Ridgway, and Bob Currie, who both saw something in me that I didn’t see in myself and let me make mistakes to learn how to be a better teacher and administrator. Your positive attitudes and can-do worldviews are inspiring;

The many excellent teachers and professors I had before starting this program, including Mrs. Kallstad, Mrs. Platisha, Mrs. Glaske, Mr. Willey, Mrs. Mader, Mrs. Ballew, Mr. Long, Dr. Batchellor, Mr. Clark, Mr. Kirk, Mrs. Donovan, Professor Northup, Dr. Wittman, Dr. Graytak, Dr. Thronson, Dr. Quist, and Professor Fox;

The many excellent teachers I worked with while in the classroom, including Don Pogreba, Laurie Simms, Jay Partridge, Marcia O'Dell, Jeannie Tweeten, Ryan Cooney, Sean Deola, Bob Ridgway, Anne Wood, Susan Quinn, Anne Sullivan, Tom Cubbage, Kathleen Prody, and too many others to count;

To others have have completed this process, including Dr. Jeff Crews and Dr. Wes Fryer, who were unending in their nudging that the best dissertation is a complete dissertation;

The thousands of students I have worked with in 25 years of classes, camps, debate tournaments, Model United Nations, and other places. I attempted to make a list of those that left an impression on me, but, I decided the pursuit was doomed once the list hit sixty names. Teaching is a tough career, not for the faint of heart or those lack a sense of purpose, but, the students I worked with day in and day out provided all the inspiration I needed to keep coming back to work;

My parents, Annie and Junior, for all of their positive love and support; the same to Pete and Lynn, for being ever-supportive of my educational pursuits.

My "kinda kid" Albin, who put a whole lot of things about 20 years in education in very real perspective and always made sure my coffee cup was full when I was in writing mode;

And finally to Alison. Thanks for putting up with all of this and more.

Table of Contents

Chapter One: Introduction to the Study

Introduction

In the 1987 autobiography titled *Odyssey,* John Scully—then the CEO of Apple Inc.—predicted that software agents would one day become the primary method with which computer users would navigate the extraordinary databases of personal and public data that we now know as the Internet (Sculley & Byrne, 1987). Apple expanded this idea to create a proof-of-concept video featuring a "knowledge navigator" that sits on a flat computing device and speaks with a university professor about his daily schedule, refers to data on an upcoming lecture, and facilitates a video call with an expert in the field (*Knowledge Navigator*, 1987).

These technologies—fodder for both wistful dreaming and future shock concerns about a human interface being inappropriate (Stasko, 1998)—are now a daily reality. The iPad and other tablet computers, digital calendars, a massive information trove via the Internet, and video conference platforms like Skype are now widely available. Twenty-four years after Scully posited the platform, Apple released Siri, a voice-controlled *intelligent personal assistant*, on the iPhone and iPad, and more recently on OSX/MaxOS-powered laptop and desktop computers. Following the introduction of Siri, voice input tools have become increasingly available for accessing and organizing information, controlling technology function, communicating with others, and engaging in e-commerce. In addition to Siri, Google's *Google Now/Google Assistant*, Microsoft Corporation's *Cortana* and, most recently Amazon.com Inc.'s *Alexa* have provided users a means of interfacing with a computer, tablet or smartphone via intelligent personal assistants and the sound of their own voice.

The widespread availability of intelligent personal assistants is of particular interest to schools. Whether schools have the funding or momentum to adopt mobile platforms in the classroom, students are more likely than not to be carrying a personal smartphone: 73% of teens have access to a smartphone (Pew Research Center, 2015), a rate that exceeds the 68% of adults who own smartphones (Pew Research Center, 2014).

Problem Statement

As schools, districts, and states focus on graduation rates, student achievement, and serving all students no matter their circumstance or needs, student engagement has become a commonly cited strategy for increasing positive outcomes in K-12 classrooms (Voke, 2002). Increasing student engagement is considered a potential solution to a wide variety of educational concerns, ranging from dropout rates to student boredom (Fredricks, Blumenfeld, & Paris, 2004).

Student engagement is particularly low among older students. Substantial evidence exists that while students start engaged and motivated in elementary school, engagement wanes in middle and high school, resulting in large numbers of students—upwards of 40 to 60%—lacking a meaningful connection to school and instruction (Marks, 2000).

Educational and consumer technology is often cited by advocates as a tool to increase engagement in the classroom (Kuntz, 2012). Claims that technology can "take learning experiences to the next level" (Brenner, 2015, para. 3) and fix dated and broken passive learning models (Sessoms, n.d.) appear frequently in popular and sales literature aimed at teachers and schools. Formal research provides a variety of results at both the micro and macro level, ranging from studies that suggest the use of technology increased engagement (Chen, Lambert, & Guidry, 2010) to those that found mixed results when students were offered opportunities to use the latest platforms to complete learning and research tasks (Calkins & Bowles-Terry, 2013).

As mobile technology continues to evolve and mature, intelligent personal assistants have become more present in widely available hardware and software platforms. Apple's Siri, Google's Google Now, Microsoft's Cortana, and Amazon's Echo all provide end users an evolving toolset offering natural language access to a platform powerful information interface. Outside education, investors and technology advocates estimate that these intelligent personal assistants will impact the day-to-day lives of everyone in numerous, personal ways, like managing health and fitness data and engaging with others on location and scheduling (Empson, 2011).

With Apple products dominating tablet market share (Purcher, 2015), Siri is of specific interest as it is integrated into a common classroom hardware platform, the iPad. Siri, too, is the subject of a wide range of views on its potential impact in the classroom. Teachers and practitioners report results that range from enthusiasm for changing the way students, teachers and content interact (thus, changing the foundation of learning) (Empson, 2011; Ratzel, 2012) to disappointment on how little the platform really served the educational market ("7 Pros And Cons Of Using Siri For Learning," 2012).

By examining technology and engagement in individual student and classroom applications, studying Siri's impact in a classroom may provide guidance on how the emerging toolset of intelligent personal assistants could change the ways that students interact with technology, teachers, and one another.

Purpose of the Study

The purpose of this study was to measure the differences in student engagement when a teacher implements purposeful instruction on using the intelligent digital assistant Siri in upper elementary and middle school science classrooms. This study was bound in space and time by inquiry restricted to observations during five months of the Spring 2017 semester in selected middle school science and upper elementary classrooms in a single district in the state of Montana.

Research Questions

The researcher proposed to answer the following central research question: Does implementation of the intelligent personal assistant Siri via purposeful introduction and instruction increase engagement of middle school science students or upper elementary students?

The researcher proposed to answer the following subquestions:

Does implementation of the intelligent personal assistant Siri via purposeful introduction and instruction

a. increase student's reported use of Siri in the classroom?

b. increase student engagement among students with

   i. higher standardized reading scores in middle school science or upper elementary classrooms? And

   ii. lower standardized reading scores in middle school science or upper elementary classrooms?

Hypothesis

The researcher proposed the following hypothesis: The implementation of Siri and purposeful technology instruction in elementary or middle school classrooms will increase student engagement in the classroom, as measured by the EvsD-Student Report instrument (see Appendix A).

Definition of Terms

For the purposes of this study, the following terms will be used:

Cortana. Cortana is a personal digital assistant available on a variety of mostly-Microsoft platforms, including Windows 10, Windows 10 Mobile, Xbox (Foley, 2014) and other operating systems like iOS and Android via an app download (Whitney, 2015).

One-to-one computing. Although confusion exists concerning what exactly constitutes a "one-to-one," or "1:1," computing environment, one-to-one "simply describes a ratio of devices to the number of students" (Richardson et al., 2013, p. 5). Thus, schools that report a 1:1 learning environment provide a device to each student.

Student engagement. The definition of engagement differs widely among researchers (Fredricks et al., 2011) and "definitional clarity has been elusive" (Appleton, Christenson, & Furlong, 2008, p. 370). This lack of clarity has filtered down into popular literature, with writers and advocates charging that experts are unwilling to define the term beyond vague notions (Finley, 2014). There have been recent trends to refer to both school engagement and student engagement, although Appleton, Christenson, & Furlong (2008) argue that student engagement is "preferred," as educational programs aim their programs at engaging learners. Skinner, Kinderman, & Furrer (2009), the authors of this study's measurement instrument provide, a general definition of engagement as "the quality of a student's connection or involvement with the endeavor of schooling and hence with the people, activities, goals, values, and place that compose it." Student engagement is generally associated with positive student outcomes, regardless of the definition or the specific definition (Klem & Connell, 2004).

"Personal digital assistant" / "intelligent personal assistant." Research-based literature and popular news sources seem to utilize these two terms interchangeably. However, the term “intelligent personal assistant” has the most formal definition, as it was defined in 2002 as part of a Google patent application:

> An intelligent social agent is an animated computer interface agent with social intelligence that has been developed for a given application or type of applications and a particular user population. The social intelligence of the agent comes from the ability of the agent to be appealing, affective, adaptive, and appropriate when interacting with the user. An intelligent personal assistant is an implementation of an intelligent social agent that assists a user in operating a computing device and using application programs on a computing device (20030167167:A1, 2003, para. 1).

There is no definitive source on what qualifies as an intelligent personal assistant as opposed to another software platform; however, crowd-sourced resources like Wikipedia list twenty different intelligent personal assistants, including Google Now, Cortana, Siri, the Blackberry Assistant and the Echo from Amazon (Wikipedia contributors, 2016). Other patent applications seem to offer other names with similar functionality, like personal virtual assistants (6757362, 2004).

Although there are differences and “quirks” between the prominent intelligent personal assistant platforms, technology commentators say that “all generally do the same thing” (Oswald, 2016).

Siri. Siri is “a built-in, voice-controlled personal assistant available for Apple users. The idea is that you talk to her as you would a friend and she aims to help you get things done, whether that be making a dinner reservation or sending a message” (O’Boyle, n.d.). Apple itself defines Siri as an “intelligent personal assistant” (“Use Siri on your iPhone, iPad, or iPod touch,” n.d.). Recently, Apple made Siri available on Apple desktops and laptops (“Use Siri on your Mac,” 2017).

Limitations

This study was limited to available classrooms at an elementary school and middle school in a K-8 school district in Montana, limited by the time allotment available and the funds required to observe the specific case in this quantitative, “quasi-experimental” design. The sample represented a school district typical to larger cities in Montana; however, since the district lies on the outskirts of an urban area, it draws students from rural areas outside the central urban population center. The results of the study may not be generalizable to other urban, suburban, and rural school districts.

This study focused on a district that has an existing one-to-one implementation of classroom iPads, which offers the research advantage of eliminating the complexity of supporting and studying multiple platforms, as might be the case in conducting this research in a bring-your-own-device implementation. In addition, the researcher did not introduce any potential harm related to student human participants, as all students will have equal access to the technology platform utilized in the treatment. The use of Siri, a choice necessitated by the availability of hardware in the participating district, may limit generalizability to other implementations, whether it is an implementation of another tool like Google Now in a one-to-one implementation, or, the use of intelligent personal assistants in bring-your-own device systems that might utilize a variety of software agents. The results of this study may also not be generalizable to districts that cannot or will not implement a one-to-one implementation of a mobile device that runs an intelligent personal assistant agent, often seen as expensive and difficult to finance and afford (Rohr, n.d.).

The participants in the study were limited to middle school science classrooms in the participating districts, which would theoretically cover the entire population of the school.

Upper elementary students in 5th grade classrooms were also considered; however, only two of four teachers have a one-to-one iPad implementation, limiting the population. Science and upper elementary classrooms were the target at the request and cooperation of the participating school and district. This could limit the generalizability of the study, as the results may not transfer to younger or older students. Additionally, any impact could be limited to science classrooms as the implemented technology tool, the Siri intelligent personal assistant, could theoretically have functionality that is best implemented in the study of science.

Delimitations

The researcher limited the treatment to one platform-specific intelligent personal assistant software agent, designed by Apple Inc. and named Siri. Apple Inc. was first-to-market with a widely available intelligent personal assistant and still dominates tablet hardware sales compared to other manufacturers ("Apple's iPad remains dominant in shrinking tablet market," 2015). This potentially limits generalizability to schools with this particular hardware and software available.

The researcher has also limited the study to a district that has an existing one-to-one computing initiative that has the appropriate hardware and software available. This potentially limits generalizability to schools with these resources available. Results may not apply to those adopting a computer lab or device cart model, as results may depend on having daily or regular access to the device.

Significance of this Study

This study aims to inform students, parents, teachers, and school administrators about the potential impact of purposefully implementing an educational technology tool like Siri in a classroom, school, and district. As technology continues to evolve and increase in functionality, schools will always take a lead in responding to how technology impacts information, work, and play.

Siri and other intelligent personal assistants are of special interest, as recent years have seen an increase in both the interest around and functionality of intelligent personal assistants, both in mobile devices and home devices like the Echo, from internet retailer Amazon. Siri gained renewed attention during the June 2016 Apple Worldwide Developers Conference as a target for expansion. Among upcoming enhancements to the platform, Siri can now be connected to third party applications, which could dramatically expand the functionality of the platform (Khosla, Huang, & Andrus, 2016). Market analysts estimate that the new functionality will increase Siri's presence on the iOS and MacOS platform and ultimately make it the center of Apple's interface strategy (Fowler, 2016). Others in the marketplace, like Google's Google Now platform on Android and Amazon's Alexa, are poised to do the same thing (Bohn, 2016; Rao, 2016). This study could provide an appropriate research basis and justification for a school or district to investigate these evolving and powerful platforms, whether Siri or one of its marketplace competitors.

More broadly, although so-called "smartphones" have been widely available to consumers for more than a decade, research on the use of these devices in the classroom is limited. Many teachers, classrooms, and schools have chosen to ban the presence of such devices in the classroom as they emerged on the market ("Schools, states review cell phone bans," n.d.), some citing research suggesting that cell phone availability decreases student achievement (Beland & Murphy, 2015). This study could provide needed research on the wisdom of implementing mobile devices in the classroom.

Outline of the Study

The second chapter of this study reviews literature related to student engagement, the role of technology in engagement, and intelligent personal assistants in the K-12 classroom. The third chapter details the data collection procedures used in this study. Chapter four reports the findings from the study, including related output tables of statistical analysis. The summary of the findings is presented in chapter five, including implications of the results and recommendations for future research.

Summary

Intelligent personal assistants are ubiquitous among the large number of smartphone users in the United States, including students in K-12 classrooms. With the need to evaluate specific technology tools in context of their impact on student learning, careful study of tools like Siri can provide teachers, schools, and districts important information about implementing these tools in classrooms.

Chapter Two: Review of Literature

This chapter is divided into three major sections. The first section will address student engagement, including justification for its focus in schools and school reform and the potential outcomes for implementing strategies for increasing engagement. The second section details the impact of technology on engagement, including a review of common, popular claims and a review of the research conducted thus far. The third section addresses the specific treatment—intelligent personal assistants in K-12 classrooms—including a review of claims in popular literature and research studies.

Ongoing Quest for Engagement

As schools, districts, and states increase attention to graduation rates, student achievement, and serving all students regardless of their circumstance or needs, student engagement has become a commonly cited strategy for increasing positive outcomes in K-12 classrooms (Voke, 2002). Student engagement advocates connect student engagement with student performance (Lopez, 2014), dropout rates, and even discipline issues (Kagan, 2010). To some, engagement stands out as the core requirement for success in educational environments (Warner, 2014).

Despite current interest in the topic, student engagement does not have a long history in annals of educational research or reform. Discussion of the topic goes back only to the 1980s (Appleton et al., 2008). Implicit in this short history is a lack of any universally accepted standard or framework with which to study, measure, or even discuss student engagement. As highlighted in Chapter One, many researchers debate the definition of engagement and substantial variation exists on how it is measured. This debate notwithstanding, engagement "continues to resonate strongly with families, students, educators, and researchers" (Appleton et al., 2008, p. 369).

Educators and practitioners—many of whom observe students who are "bored, unmotivated, and uninvolved" (Appleton et al., 2008, p. 369)—recognize student engagement as important and essential to learning (Finn & Zimmer, 2012). However, teachers themselves can confuse engagement and other classroom outcomes. For example, pre-service (Finley, 2014) and career teachers (DeWitt, 2016) alike demonstrate that engagement is sometimes confused with compliance and may fail to see the proactive steps necessary to engage students in the classroom.

Impact of engagement on students and classrooms. Student engagement is associated with a number of important impacts on students and their schools, including positive outcomes in student achievement (Marks, 2000; Zhang, 2014) and decreasing the dropout rate (Manlove, 1998). The literature suggests several potential positive outcomes.

Positive student outcomes. Student engagement is associated with a variety of positive personal outcomes for individual students. Student engagement is widely considered essential to the learning process and is correlated with increased attention in class (Russell, Ainley, & Frydenberg, 2005) and completing class assignments (Fredricks et al., 2004). Students who are engaged are more likely to approach classroom tasks in an eager and enthusiastic way and enjoy challenging lessons and content (Klem & Connell, 2004; Stipek, 1996).

All of these factors together can positively impact student achievement. Students who have internal motivation and engagement are more likely to be successful than those who have only external motivation (Sheldon & Biddle, 1998). This is particular poignant in the era of accountability and testing, ultimately calling into question the impact of high-stakes testing

(Voke, 2002). Ultimately, student engagement is also positively correlated with post-secondary access and achievement (Finn & Owings, 2006).

Conversely, unengaged and disengaged students pay a high price. Direct impacts on students disengaged include the persistent disadvantages of not finishing high school, including “unemployment, poverty, poor health, and involvement in the criminal justice system” (Committee on Increasing High School Students’ Engagement and Motivation to Learn, Board on Children, Youth and Families, Division of Behavioral and Social Sciences and Education, & National Research Council, 2003, p. 1).

Decreased dropout rates. While obviously related to individual student outcomes, student engagement can also be seen through a broader policy lens. For policymakers seeking to impact dropout rates, engagement may be a strategy for keeping students in school. Students who are disengaged from school report alienation or estrangement, which may be countered through strategies to increase student engagement (Fredricks et al., 2004). Student engagement is closely associated with student graduation rates and conversely, dropout rates. In fact, student engagement is now considered to be “the primary theoretical model for understanding dropout and is necessary to promote school completion” (Appleton et al., 2008, p. 372). Engagement matters in a nuanced way. With dropping out of school seen as a gradual process (Finn, 1989), as opposed to a dramatic, one-time event, engagement can be used as an early intervention aimed as those “at risk” for dropping out of school (Appleton et al., 2008).

Engagement has been cited as a critical component of large, statewide efforts to increase the graduation rate, including the Graduation Matters Montana initiative, a statewide effort to increase graduation rates spearheaded by former state Superintendent of Public Instruction Denise Juneau. Eleven different Graduation Matters Montana Challenge Fund grants in 2016 mention “engagement” as a component of their on-the-ground efforts to increase the graduation rate in their local school district (Office of Public Instruction, 2016).

Despite the obvious focus on engaging “at-risk” students, some argue that schools should be employing engagement efforts toward all students. School reform efforts have concentrated on engagement as a core construct for improving schools and represent “an essential pathway in a process through which motivational and other constructs influence important school-related outcomes” (Appleton et al., 2008, p. 382). Ultimately, “the primary appeal of the engagement construct is that it is relevant for all students” (Christenson, Reschly, & Wylie, 2012, p. vii).

Increased teacher satisfaction. Student engagement might also have a significant impact on teachers, including their satisfaction and enjoyment as classroom teachers. Despite this potentially symbiotic relationship, little is known about what factors and components of student engagement might impact teachers. However, researchers are beginning to dig deeper into the question (Martin, 2006). Teacher behavior and student engagement share a reciprocal relationship, according to empirical evidence (Skinner & Belmont, 1993)**.**

Strategies to increase engagement. Social science researchers, educational reform advocates, and professional development providers offer a wide variety of potential strategies for increasing student engagement in different classroom environments.

Popular literature and research journals alike abound with articles bearing attention-grabbing headlines that advertise engagement-centered strategies. A blog entry on the George Lucas Educational Foundation site *Edutopia* called “Planning for Engagement: 6 Strategies for the Year” cites strategies including authentic learning, collaboration, and integration of technology as critical for increasing student engagement (Block, 2013). The journal *CBE Life*

Science Education published an article the same year called "Structure Matters: Twenty-One Teaching Strategies to Promote Student Engagement and Cultivate Classroom Equity" that suggests other strategies, including utilizing wait time and learning students' names (Tanner, 2013). Good instructional practice, planning, and strategies are associated with both increased student engagement and decreased disruption from students with behavior problems.

Certain individual teacher practices and strategies have been identified as effective or ineffective in increasing student engagement in the classroom. In the large lecture halls of college and universities, for example, students have been receptive to professors using notecards to organize question-asking behavior and assign tasks in small groups as a strategy to increase student engagement (Broeckelman-Post, Johnson, & Schwebach, 2016). Developing lessons or units around a problem, commonly referred to as problem-based learning, is closely associated with increased student engagement, and often student achievement (McHarg, Kay, & Coombes, 2012; Rotgans & Schmidt, 2011). Interspersing multimedia materials in an online or blended learning environment is another potential strategy for increasing student engagement (Bledsoe, 2013).

Teachers can also plan classroom environments, instructional units, and lessons around broad philosophies to increase engagement. Building student autonomy into the classroom by providing choice, minimizing controls, offering rationales for instructional choices, and respecting student disagreement can all promote student engagement as well (Assor, 2012). In addition, teachers can actively include students in planning lessons and building the learning environment and take a student's perception of relevance into account (Hipkins, 2012). Assessment strategy and philosophy can also have an impact on assessment, with feedback systems tied to learning goals (as opposed to performance comparisons) offering the closest association to motivation and engagement. Formative assessment schemes are also aimed at increasing student self-determination and ultimately increasing engagement (Nichols & Dawson, 2012).

Conversely, many factors could lead to decreased student engagement. In recent years, the test-focused accountability systems widely employed in public schools have been blamed for decreasing student engagement (Barlowe & Cook, 2016). However, research into the link between standardized tests and disengagement is thin and represents a topic for future study (Hipkins, 2012). Critics of schools cite the lack of choice, inflexible learning environments, and lack of rigor as other factors encouraging disengagement (Washor & Mojkowski, 2014).

As discussed earlier, some critics draw a line between authentic student engagement and simply classroom compliance. A classroom of students, carefully paying attention to a teacher and even giving off signs of tracking the lesson or discussion, may not be authentically engaged but rather, simply compliant. Those drawing this distinction suggest dynamic learning environments, careful attention to teacher-student relationships, and fluid and malleable classroom environments may increase authentic student engagement (DeWitt, 2016).

Finally, student engagement itself is complex, and looking at individual components of engagement may not always yield understanding of the relationship between a given strategy and its outcome. The context in which a student exists—including his or her peers, family, and community, as well as the classroom and school—influences engagement (Appleton, Christenson, Kim, & Reschly, 2006), which justifies this study's approach of looking at one group of students with a pre- and post-survey, controlling for those contexts.

Measuring and studying engagement. The lack of a universally accepted definition coupled with competing visions of the construct has brought little clarity to the issue. Still, many researchers insist that engagement is important and continues to be associated with positive student outcomes, despite the lack of definition or conceptual clarity (Klem & Connell, 2004). Researchers agree that the concept must continue to be researched and explored (Christenson et al., 2012; Fredricks & McColskey, 2012), justifying studies like this one.

Fredricks, Blumenfeld and Paris (2004) published a detailed review of 30 years of studies and perspectives on “engagement,” leading to various frameworks and constructs available to look at student engagement in schools. Instruments exist that look at engagement ranging from one to many factors, any of which could be utilized to look at engagement in different educational contexts. More recently, Fredricks et al. (2011) detailed 21 specific instruments aimed at measuring engagement in the classroom.

Skinner et al. (2009) used four indicators to identify levels, including two behaviors (engaged behavior and disaffected behavior) and two emotions (engaged emotion and disaffected emotion). Fredricks et al. (2004) posited alternative factors around engagement; however, Skinner et al. (2009) report that the four-part analysis is a better representation. Skinner et al. (2009) implemented a study to clarify their framework to develop an instrument.

Educational Technology and Engagement

Advocates often cite educational and consumer technology as a tool for engagement in the classroom (Jimenez, 2015; Kuntz, 2012; Snehansu, 2013; US Department of Education, n.d.). Popular literature is abundant with teachers, school, professional development speakers, and vendors asserting that technology is a critical component of engagement. Whether technology-infused instructional strategies to increase student audience by utilizing student publishing on the Internet (Block, 2013), providing personalization of path or pace (Brenner, 2015), or revolutionizing the learning environment through student empowerment (Patnoudes, n.d.), claims that technology is critical for those seeking greater student engagement in classrooms abound. Moreover, pronouncements that technology can “take learning experiences to the next level” (Brenner, 2015, para. 3) and fix dated and “broken” passive learning models (Mourning, n.d., para. 2) appear frequently in popular and sales literature aimed at teachers and schools.

Formal research on the issue of technology engagement provides a variety of results at both the micro and macro level, ranging from studies suggesting that the use of technology increases engagement (Chen et al., 2010; Laird & Kuh, 2005) to those that found mixed results when students were offered opportunities to use technology platforms to complete learning and research tasks (Calkins & Bowles-Terry, 2013).

There are a number of studies that look at specific technologies in the context of engagement, including interactive whiteboards (Beeland, 2002) and social media tools such as Twitter (R. Junco, Heiberger, & Loken, 2011) and Facebook (Junco, 2012).

Teachers themselves report that technology increases student engagement in their classroom. A recent study asked teachers to describe an exemplary lesson utilizing technology; respondents named everything from educational games to interactive writing exercises. A majority of those teachers reported that their perceived level of student engagement was high during these classroom lessons (Hur, Shannon, & Wolf, 2016).

Engagement in one-to-one environments. More specific to the issues of this study, intelligent personal assistants could be implemented or accessed in a number of different environments, including one-to-one computing environments (where students all have access to a device, either during class or assigned to them for class and home use), bring-your-own-device policies (where students utilize personal smartphones, tablets and/or laptops in the classroom environments), or even labs of tablets or desktop/laptop computers. This study will focus on a school that has implemented one-to-one tablet devices, making a look at the literature around one-to-one computing germaine.

Integration of devices in the classroom has proven engaging in particular contexts. For example, iPads and other tablets—which offer access to different apps that can provide digital text with overlays and other enhancements—can be highly engaging in the context of literacy instruction (Hutchison, Beschorner, & Schmidt-Crawford, 2012), though the cited study was based on a small number of case studies with specifically designed lessons. Mouza (2008) looked at one-to-one laptop implementation in a single urban school serving underprivileged youth and found both qualitative and quantitative evidence of increased engagement. Urrea (2010) studied an early implementation of one-to-one computing in a rural school in Costa Rica, reporting students to be very engaged in lessons and the learning environment, although this study, too, was based on a small number of students in single classroom and did not utilize any of the validated methods for measuring student engagement.

Researchers have also specifically called for more study on the question of the impact of technology and media on engagement and related concepts like curiosity and interest (Arnone, Small, Chauncey, & McKenna, 2011), making this proposed research timely and needed.

Technology fails engagement. There is a broad assumption that integrating technology in the classroom environment is naturally engaging. This assumption leads to expectations that providing universal access to devices or offering new or otherwise novel learning environments will bring the engagement that teachers, schools and policy-makers desire. However, evidence exists that the classroom environment and relationship between technology and learning is too complex to accept that assumption universally (Donovan, Green, & Hartley, 2010).

Student engagement is also at the center of experimental learning environments with a technology focus. For example, so-called massive open online courses—better known by their acronym *MOOCs*—are online courses developed by professors, colleges or universities to be delivered in an inexpensive or free platform to any who care to attempt the course. MOOCs were touted at the time as the great equalizer of higher education, with some proponents boldly predicting that all higher education would be delivered by just 10 institutions within this century (Pope, 2014). Thus far, MOOCs have yet to fulfill that promise, with some researchers suggesting that their success relies primarily on the ability of the environment to maintain engagement (Ramesh, Goldwasser, Huang, Daume, & Getoor, 2014).

Universal access to devices may not provide either an immediate or lasting impact on engagement. A longitudinal study of South Korean middle school students in a one-to-one laptop environment found an initial gain in student engagement followed by a decline over time (Hur & Oh, 2012), although the authors admit their sample was small. Another study looking at different implementations of laptop access programs for middle school students found that there was little impact on engagement, and in fact, laptop implementation often introduced a variety of off-task behaviors to the classroom (Donovan et al., 2010).

Implementation of technology may also have unintended consequences for other school measures or outcomes. One study that found a technology immersion program brought positive changes to student technology proficiency, classroom activities, and student behavior but ultimately had little impact on academic achievement and was correlated with negative changes in student attendance (Shapley, Sheehan, Maloney, & Caranikas-Walker, 2011).

Others argue that a lack of planning, meaningful implementation, and vision limits the impact of technology in the classroom for anything but the most mundane or low-level tasks.

For these critics, one-to-one computing has become no more than an expensive pencil program, as the learning environment looks no different after devices are purchased, limiting the impact it might have in the classroom (November, 2013).

Intelligent Personal Assistants and the K-12 Classroom

Intelligent personal assistants are a relatively recent phenomenon, explaining the lack of research related to their application to the K-12 environment. However, there is ongoing research on intelligent personal assistants in the broader consumer market that can provide some guidance in the educational space.

Voice recognition to intelligent personal assistants. Voice recognition has long history in personal computing, going back over three decades (Pinola, 2011). Tools like Dragon Naturally Speaking have been available to consumers since the 1990s but have found little implementation beyond niche uses, as for those who are physically unable to type (Moore, 2016). However, intelligent personal assistants go beyond mere voice recognition. The intelligent personal assistant provides much more functionality, including access to databases on a device or the Internet to increase the variety and accuracy of answers and understanding more complex commands and requests (Sejnoha, 2013).

Intelligent personal assistants are poised to become “ubiquitous” as evolving voice technologies become more functional to the end user (Tuttle, 2015, para. 8). Conversations with intelligent personal assistants are likely to become human-like with the evolution of so-called *natural language understanding* (NLU) (Tuttle, 2015). Connection to apps, databases and other Internet resources could make intelligent personal assistants “crazy smart” (Pierce, 2015, title).

Intelligent personal assistants can appear misleadingly simple, but they are in fact much more complex than a simple interface for a search engine. Although Apple does not publicly discuss the technology that underlies Siri, Apple's patent applications describe a complex relationship with the vocal search query and the databases underlying the platform. For example, Apple uses contextual language to help hone the search and correct transcription errors (Aron, 2011).

Intelligent personal assistants are now available on the vast majority of smartphone platforms, with implementations by Google's Android, Apple's iOS, and Microsoft's Windows 10. Despite its ubiquity, the tool has not seen wide implementation of the platform with end users, with few utilizing intelligent personal assistants every day. Liao (cited in (Moore, 2016)) claims that as few as 13% of those who have access to Siri use it daily. This phenomenon might be explained by the variety of user-created videos showing voice recognition errors and other platform issues on social sharing sites like YouTube (Moore, 2016).

Nevertheless, use of intelligent personal assistants is poised to increase in the future. The market size for intelligent personal assistants is estimated to increase dramatically in coming years. Commentators describe an "arms race" between the major providers of such tools, including Google, Microsoft, and Apple. Each platform is developing similar functionality based on a different set of assumptions. For example, Microsoft's Cortana asks users for permission to access information, while Google's Google Now tool attempts to anticipate an end user's needs based on search and email. Ultimately, voice control and the underlying intelligent personal assistant could become the gateway to all devices and their applications (Waters, 2015).

At the time of this literature review, all of the major intelligent personal assistant providers had released updates to their platform to expand functionality that might increase its use by end users. Apple announced that Siri will now have the ability to directly connect with applications—including applications not created by Apple (Fowler, 2016), while Google Now will be able to understand multiple commands in a single request and connect with applications to complete tasks (Brandom, 2016). Many commentators agree that the advanced processing and integration with applications, along with the ability to interact with the increasing number of devices that will be network-connected (sometime referred to as the “Internet of things”), make the intelligent personal assistant a fundamental component of all of mobile device platforms (Fowler, 2016).

Intelligent personal assistant criticism. The power of intelligent personal assistants is not universally praised. Some argue that intelligent personal assistants like Siri, Cortana, and Google Now simply lay on top of a search engine query and do little to provide any unique insight or knowledge (Dale, 2015). This argument provides rationale to focus on Siri as a target for research, since Siri accesses a specific database, Wolfram Alpha, as part of its connected services.

Intelligent personal assistants may also face a steep adoption curve. As discussed earlier, there is ample evidence that consumer adoption rates have been low. In an attempt to explain why, Moore (2016) looks at the current state of voice integration with existing intelligent personal assistants. As it stands now, our attempts to make intelligent personal assistants more flexible and human-like might have actually decreased the usability of the platform due to its lack of human-like responses and interaction. Moore argues that spoken language might be “all or nothing,” (2016, p. 10) making the adoption curve so steep that it may only happen in the long term. Moore is careful to note that this does not mean we should abandon these tools; rather, it is likely that we will develop a language to interact with intelligent personal assistants that acknowledges the gaps between humans and machines, not unlike how humans speak to dogs.

Intelligent personal assistants also face questions of user privacy and storage of data. Early studies of Siri noted that the data exchange back and forth between devices and the powerful servers that process the data expose devices to new methods of malware and attack (Damopoulos, Kambourakis, Anagnostopoulos, Gritzalis, & Park, 2012). In addition, the more personalized features of intelligent personal assistants that track location and habits in juxtaposition with data from searches and email may be more than end users are comfortable with (Bates, 2014). However, this likely applies more to individual users than to school-based users, as most educational technology vendors have made commitments to student data privacy. For example, Google, Apple and Microsoft have all signed the "Student Privacy Pledge" (Future of Privacy Forum, n.d.), although not all involved in education agree that it is enough to protect student data (Molnar, 2014).

Like any educational technology, Siri's platform is subject to hardware and network resources in a school or classroom. Until recently, Siri was only available on Apple mobile devices, including later generation iPads, iPhones and iPod Touches (Apple, Inc., n.d.), and is now available on later generation OSX/MacOS-powered desktops and laptops (Eadicicco, 2016). Siri's performance is also subject to network resources and bandwidth, as the language processing and database access happens on cloud-based servers and not the local device. Slow or inconsistent network access may delay results, ultimately impacting user experience (Assefi, Liu, Wittie, & Izurieta, 2015).

Intelligent personal assistants and students. Much of the available research around the impact of intelligent personal assistants on adolescents has been around the question of whether mobile devices distract drivers, teen or otherwise. The California Department of Motor Vehicles completed an extensive review of literature on mobile devices and distracted driving, looking at numerous studies in and out of the United States and concluded that while there is not substantial evidence that talking on a mobile phone increases the risk of a crash, crash risk *was* found to increase significantly as a result of the visual-manual subtasks required of handheld cell phone use" (Limrick, Lambert, & Chapman, 2014). As intelligent personal assistants have become more common, research is now focusing on whether these tools offer relief from the risk of mobile device use in the car, with a 2015 study suggesting that the use of Siri, Google Now and Cortana by drivers deserves scrutiny due to the substantial cognitive workload required to complete common tasks (Strayer, Cooper, Turrill, Coleman, & Hopman, 2015).

Not specific to students, future-looking computer scientists have proposed models where intelligent personal assistants support humans during complex tasks. Bosse et al. (2009) propose that intelligent personal assistants could be set up to measure data from end users, like the cognitive load of a worker, and then provide timely and direct assistance to send the user in the right direction. Although this model did not directly envision classroom use, one could easily apply such a device to classroom environment, particularly with struggling learners.

Summary

Engagement remains an important goal for all stakeholders in education. With evidence that the lack of engagement is associated substantial negative outcomes for students, there is interest among those planning and delivering instruction on the best ways to engage students in classrooms. Technology is often cited as an important tool in engaging students in classroom; however, research has shown that implementation of technology is not guaranteed to engage students, necessitating research on individual tools and their impact.

As a relatively new tool, intelligent personal assistants have not received the attention of many researchers to this point. This research study is an important start to the body of research around this tool in K-12 school environments.

Chapter Three: Methodology

This chapter describes the design of this research study. The research methods and design were used to determine if the implementation of Siri in elementary and middle school classrooms is associated with increased student engagement. The student participants attended an elementary or middle school in the same K-8 district in Montana. Each participating student completed the Student Engagement vs. Disaffection with Learning-Student Report (EvsD) engagement survey instrument as a pre-assessment. Classrooms were divided into treatment groups and control groups where possible, and treatment groups were given instruction by their classroom teachers on using Siri to supplement learning opportunities and lessons inside the classroom. Teachers were observed utilizing a simple quantitative observation method to determine whether they were instructing students on the use of Siri. After 12 to 15 weeks of the formal treatment protocol, student participants were given a post-treatment administration of the EvsD engagement survey. The EvsD results were analyzed for increased engagement in treatment groups.

Research Design and Procedures

The researcher adopted a quantitative research approach, using a survey-based instrument with a Likert scale to measure student engagement before and after the treatment. In addition, the researcher used a quantitative observation protocol to determine whether the classroom teacher was integrating and encouraging intelligent personal assistant use in the classroom in treatment groups, while engaging in no such activities with the control groups. A quantitative research approach was an appropriate design choice as the researcher had a clearly identifiable treatment that could be tested to determine an outcome (Creswell, 2009).

The study was conducted in an elementary (K-8) district in Montana. The study took place in five classrooms—three middle school science classrooms and two 5th grade classrooms. After receiving informed consent from the teacher-participants themselves and then the student's parents, the researcher sought student assent. The resulting student participants comprised the sample of the population. As the sample was self-selecting, it may limit generalizability (Kukull & Ganguli, 2012).

In the middle school classrooms, the researcher divided each teacher's class periods into control groups and treatment groups by random draw, meeting the assumptions necessary for the use of inferential statistics (Pallant, 2007). In the two elementary classrooms, a control group was not possible, as the teachers do not work with more than one distinctive group of iPad users. Student participants were not randomly assigned to the treatment or control groups, allowing only quasi-experimental statistical inspection.

Role of the Researcher

In this study, describing role of the researcher is important to understand the design of the data collection and methodology. The researcher initially proposed the study to teacher-participants, receiving permission to conduct the study in their classrooms and collect data. The researcher provided direct professional development to the teachers on the treatment protocol (see Appendix B) and also on procedures related to the study.

The researcher collected data in two ways: a pre- and post-survey and classroom observation of teachers. The observation protocol did not focus on the nature or quality of instruction or technology related to Siri, but, rather, focused entirely on the question of whether the treatment was, indeed, delivered by teacher-participants.

Research Questions and Hypothesis

The researcher explored the relationship between the direct application of instruction encouraging the use of the Siri, and student engagement as measured by the EvsD-Student Report.

Research questions. The researcher proposed to answer the following research question: Does implementation of the intelligent personal assistant Siri via purposeful introduction and instruction increase engagement of middle school science students or upper elementary students?

To best answer the research question, the researcher proposed two sub questions to complete a detailed analysis: Does implementation of the intelligent personal assistant Siri via purposeful introduction and instruction

a. increase students' reported use of the tool in the classroom?

b. increase student engagement among students with

    i. higher standardized reading scores in middle school science or upper elementary classrooms? and

    ii. lower standardized reading scores in middle school science or upper elementary classrooms?

Hypothesis. The researcher proposed the following hypothesis: The implementation of Siri and purposeful technology instruction in elementary or middle school classrooms will increase student engagement in the classroom, as measured by the *Engagement Versus Disaffection with Learning-Student Report* instrument.

To provide as many opportunities as possible to find potential differences between the variables, the researcher proposed the following sub-hypothesis:

Hypothesis 1 (Student Familiarity Data Test). The implementation of Siri and purposeful technology instruction in elementary or middle school classrooms will increase students' self-reported familiarity with Siri.

Hypothesis 2 (Student Use Classroom Data Test). The implementation of Siri and purposeful technology instruction in elementary or middle school classrooms will increase students' self-reported weekly use of Siri to complete classroom assignments in school.

Hypothesis 3 (Student Use At Home Data Test). The implementation of Siri and purposeful technology instruction in elementary or middle school classrooms will increase students' self-reported weekly use of Siri to complete classroom assignments at home.

Hypothesis 4 (Student Engagement Overall Test). The implementation of Siri and purposeful technology instruction in elementary or middle school science classrooms will increase student engagement in the classroom, as measured by the *Engagement Versus Disaffection with Learning-Student Report* instrument.

Hypothesis 5 (Student Engagement Individual Teacher Test). The implementation of Siri and purposeful technology instruction in elementary or middle school science classrooms will increase student engagement in an individual teacher's classroom, as measured by the *Engagement Versus Disaffection with Learning-Student Report* instrument.

Hypothesis 6 (Student Engagement High Reading Test Score Test). The implementation of Siri and purposeful technology instruction in elementary or middle school science classrooms will increase student engagement for students with the highest third of reading scores, as measured by the *Engagement Versus Disaffection with Learning-Student Report* instrument.

Hypothesis 7 (Student Engagement Low Reading Test Score Test). The implementation of Siri and purposeful technology instruction in elementary or middle school science classrooms will increase student engagement for students with the lowest third of reading scores, as measured by the *Engagement Versus Disaffection with Learning-Student Report* instrument.

Null hypothesis. The researcher proposed the following null hypothesis: The implementation of Siri with purposeful technology instruction in elementary or middle school classrooms will not increase student engagement in the classroom, as measured by the *Engagement Versus Disaffection with Learning-Student Report* instrument.

The researcher also proposed the following null hypotheses for the previously proposed sub-hypotheses.

Null Hypothesis 1_0 *(Student Familiarity Data Test).* The implementation of Siri and purposeful technology instruction in elementary or middle school classrooms will not increase students' self-reported familiarity with Siri.

Null Hypothesis 2_0 *(Student Use Classroom Data Test).* The implementation of Siri and purposeful technology instruction in elementary or middle school classrooms will not increase students' self-reported weekly use of Siri to complete classroom assignments in school.

Null Hypothesis 3_0 *(Student Use At Home Data Test).* The implementation of Siri and purposeful technology instruction in elementary or middle school classrooms will not increase students' self-reported weekly use of Siri to complete classroom assignments at home.

Null Hypothesis 4_0 *(Student Engagement Overall Test).* The implementation of Siri and purposeful technology instruction in elementary or middle school science classrooms will not increase student engagement in the classroom, as measured by the *Engagement Versus Disaffection with Learning-Student Report* instrument.

Null Hypothesis 5_0 (Student Engagement Individual Teacher Test). The implementation of Siri and purposeful technology instruction in elementary or middle school science classrooms will not increase student engagement in an individual teacher's classroom, as measured by the *Engagement Versus Disaffection with Learning-Student Report* instrument.

Null Hypothesis 6_0 (Student Engagement High Reading Test Score Test). The implementation of Siri and purposeful technology instruction in elementary or middle school science classrooms will not increase student engagement for students with the highest third of reading scores, as measured by the *Engagement Versus Disaffection with Learning-Student Report* instrument.

Null Hypothesis 7_0 (Student Engagement Low Reading Test Score Test). The implementation of Siri and purposeful technology instruction in elementary or middle school science classrooms will not increase student engagement for students with the lowest third of reading scores, as measured by the *Engagement Versus Disaffection with Learning-Student Report* instrument.

Sample, Population, and Participants

The population. The population is comprised of 5th to 8th grade students in an elementary school district in Montana. The school district has no high school and students who complete 8th-grade instruction in the district matriculate to a high school in a nearby district in the same county. According to the Montana Office of Public Instruction's Growth and Enhancement of Montana Students (GEMS) database, the total 2015-2016 school year enrollment count for the district in this study is 1514 students. Demographically, 40.2% of students are reported as "economically disadvantaged," 1.6% demonstrate limited English proficiency, and 9% participate in special education (Office of Public Instruction, n.d.).

The target district was selected for this study due to their implementation of "one-to-one" iPads in many classrooms across the district. Each middle school student was individually assigned an iPad at the beginning of the school year and was allowed to access the device throughout the school day, with guidance from the classroom teacher. In addition, a select number of the elementary classrooms have access to student-assigned iPads to use for classroom instruction.

The sample. The researcher initially approached the district requesting access to one or more classroom teachers, and ultimately, their students, to conduct this study. The administration in the district offered access to almost all middle school students through their science classes, plus two additional 5th grade classes that have implemented one-to-one iPads in their classroom environment. The data collected from the 5th grade classrooms may have limited applicability due to the lack of defined control groups or treatment groups.

Utilizing a protocol developed in consultation with the researcher's Institutional Review Board, the researcher solicited participation from all of the identified classroom teachers. All teachers agreed to participate in the study. The researcher then worked with the district administration to send home parent permission forms via US mail. From the group that returned parent permission forms, the researcher worked with that group to receive student assent. The resulting sample was made up of 32.4% of the population.

Variables in the Study

Independent variable. The independent variable in this study was the application of direct, purposeful instruction encouraging the use of Siri in the target classrooms. For the duration of the study, students in treatment classrooms were given instruction from the classroom teacher about the use of Siri as an instructional tool, including description of different categories of student Siri use (see Appendix B). In addition to introducing Siri as an instructional tool after the pre-assessment survey, teachers were encouraged to engage in observable classroom events related to Siri's use, including modeling, demonstration, redirection, correction, and praise (see Appendix C, detailing the observation protocol).

The researcher observed the direct introduction of Siri in the treatment classrooms, as well as selected days in the classrooms to look for evidence of the implementation in both treatment and control classrooms. The observations resulted in a binary score: Either the teacher was engaged in the purposeful implementation of Siri (1) or they were not engaged in the purposeful implementation of Siri (0). The binary nature of this data makes the variable a nominal variable with limited statistical implications.

Dependent variable. The dependent variable in this study was student engagement, as measured by the EvsD-Student Report survey instrument. The researcher examined the differences in student engagement and the facets of engagement identified in (Skinner et al., 2009), pre- and post-treatment, in student participants. As the survey design utilized a Likert scale, the resulting data will be ordinal (Linebach, Tesch, & Kovacsiss, 2014; Norman, 2010; Triola, 2010).

Data Collection Procedures

Instrument and materials. The researcher utilized two tools to measure the dependent variables in the study.

Student engagement was measured with the *Engagement Versus Disaffection with Learning-Student Report (EvsD)* instrument. Skinner et al. (2009) developed the EvsD, based on earlier work by Wellborn (1991). The tool has three components: a student survey, a teacher reporting tool, and an observation protocol. The researcher used the student survey in its entirety. The researcher did not utilize the teacher survey tool or the student observation tool due to the time commitment involved for participating teachers. As initially presented by Skinner et al. (2009), the student observation tool and teacher survey were used in part to validate the student survey, making the student survey sufficient to measure student engagement. Skinner concluded that scores from the assessments are "satisfactory markers of the quality of children's participation in academic activities in the classroom" (Skinner et al., 2009, p. 517).

This instrument provided several advantages for the study:

- Skinner et al. (2009) provide a framework for engagement in addition to an instrument. The framework includes a "motivational conceptualization of engagement" (Skinner et al., 2009) and contributes to the ongoing discussion and debate about engagement in the classroom.
- While the instrument authors indicate that the instrument does not represent a comprehensive measurement of engagement, "the features it [the instrument] includes are core indicators of engagement in the classroom and meet the definitional criteria specified in recent authoritative reviews of the concept" (Skinner et al., 2009, p. 494).
- The tool has been validated (Fredricks et al., 2011) both by administering two different surveys (the student survey and the teacher-completed survey) and by a series of observations by the researchers (Skinner et al., 2009).
- The tool was included in a comprehensive list of more than 20 different engagement evaluation tools, co-authored by a prominent authority in the field. Although the report did not rank the tools, it did exclude many tools for not meeting standards for acceptable validity levels (J. Fredricks et al., 2011).

The EvsD survey instrument (see Appendix A) was used to establish a baseline with student participants in a pre-treatment administration. The survey contains 20 items evaluated on a Likert scale, plus four additional questions aimed at determining the use of Siri by the student. The survey results were delivered back to the researcher's faculty advisor, who anonymized the data for the researcher. The teacher-directed treatment then occured in treatment classrooms. 10 to 12 weeks after the treatment was administered, student participants were given a second administration of the EvsD student survey.

The independent variable, the teacher's implementation of Siri, was measured by a quantitative observation method. The researcher observed both treatment and control classrooms for evidence of teacher instruction focused on Siri, looking for evidence of modeling, demonstration, redirection, correction, or praise utilizing the observation protocol (see Appendix C). At the conclusion of the study period, the researcher used the results of that data to determine if the teacher encouraged Siri use in the classroom. Treatment classrooms that do not have evidence of teacher introduction and/or encouragement of Siri use were candidates for exclusion from analysis, as questions might exist that that treatment would be a factor in any change in student engagement. Control classrooms that have evidence of teacher instruction and/or encourage of Siri use were candidates for exclusion as well.

Treatment protocol. Once teachers agreed to participate, their classes were divided into a control group and a treatment group. By random draw, the teacher's first-half or second-half of classes during their schedule were selected to be the treatment group to receive the direct implementation of Siri in the classroom. The control group received no instruction or encouragement concerning Siri use, although control group participants continued to have access to an iPad and Siri on their school-issued device. The upper elementary classrooms were not divided into a control and treatment group since school scheduling did not allow the researcher to do so. In those cases, both teachers administered the treatment to their homeroom students, with measurements of engagement and treatment application occurring in each classroom.

Teachers participating in the study received direct training regarding the treatment protocol. The training included a half-day professional development workshop taught by the researcher on the use of Siri in the classroom, including possible Siri commands useful to students in a classroom environment (see Appendix B). Teachers were individually tasked with determining how they wanted to introduce Siri to their students. The researcher did not seek to evaluate the quality of the individual teacher's approach to introducing and implementing Siri, but, rather, just confirmed the existence of a strategy in target classrooms.

Other data collection. The researcher also requested data on the student sample from the school district administration, including the local student identifier, science class assignment, and/or teacher, and standardized test scores from the Spring 2016 administration. This data was delivered to the researcher's faculty advisor, who anonymized the data for the researcher.

Reliability. Skinner et al. (2009) provide a detailed description of their efforts to determine if student self-reports of engagement, utilized in the EvsD-Student Report instrument proposed in this study, are reliable. Their work attempted to determine validity and reliability of student engagement instruments, including a student report, a teacher report and *in vivo* observation. For both the student self-report and the teacher observation instrument, "indicators of engagement and disaffection were consistently linked in theoretically expected ways with individual and interpersonal factors hypothesized to shape motivation" (Skinner et al., 2009, p. 517).

The Chronbach's alpha for the EvsD-Student Report instrument is reported in Skinner et al. (2009). Skinner et al. (2009) detail an administration of the EvsD-Student report that includes a Fall and Spring administration of the survey, measuring four identified components of engagement. Behavior engagement's Chronbach's alpha was reported at .61 (Fall) and .72 (Spring). Behavior disaffection's Chronbach's alpha was reported at .71 (Fall) and .78 (Spring). Emotional engagement's Chronbach's alpha was reported at .76 (Fall) and .82 (Spring). Emotional disaffection Chronbach's alpha was reported at .83 (Fall) and .85 (Spring). The instrument authors note that internal reliability of the student measures falls "below the generally accepted standard of .80," subjecting some of the correlational results to measurement error (Skinner et al., 2009).

Summary

The design of this research intended to determine the differences between the independent variable of the implementation of direct instruction aimed at Siri in the classroom, and the dependent variable of the level of student engagement. The population and sample, along with the units of analysis, were discussed, along with the rationale for each.

Chapter Four: Research Findings

This chapter describes the data analysis process the researcher used and reports specific results. This study examined the relationship between the implementation of Siri in classrooms in a K-8 district in Montana and student-reported engagement in those classrooms. Students in middle school science classrooms were divided into control and treatment groups, while students in 5th grade classrooms were all assigned treatment groups due to class scheduling. Students in all groups were given pre- and post-surveys, and students identified for treatment groups were given specific instruction on use of Siri in an education context.

Population and Sample Size

As discussed in Chapter 3, the sample was determined by teachers initially agreeing to participate in the study. Then, parents and students gave permission and assent to participate, creating a self-selected sample. Table 1 reports the population size and participation rates.

Table 1

Study Participation Rates in the Target District

Grade Level/Teacher	Total Number of Students (Population)	Total Participating in the Study (Sample)
5th Grade (Teacher 1)	24	11
5th Grade (Teacher 2)	26	8
6th Grade (Teacher 3)	115	62
7th Grade (Teacher 4)	134	36
8th Grade (Teacher 3)	23	4
8th Grade (Teacher 5)	115	33

Note. Teacher 3 teaches one section of 8th grade science in addition to her/his 6th grade assignment.

Data Analysis Described

After data collection was complete, the researcher took all data sets and organized the data in Google Sheets to create an organized workflow and conduct an efficient analysis. The data sets collected are the pre- and post- raw surveys, which were collected and given to the researcher's faculty advisor to code with a student code number to shield identity; the teacher observation notes, which were collected per utilizing the observation note sheet (see Appendix C); and the student test scores, which were collected and delivered to the researcher's advisor to code with a student code number to shield identity. All inferential statistical tests were conducted using IBM SPSS Statistics Version 25.

Teacher Implementation Tests. The researcher analyzed the quantitative observation data to determine if evidence of the protocol, teacher-directed instruction related to Siri, was present in classrooms. The researcher observed each class period three or more times throughout the study period to look for evidence of teacher introduction and encouragement of Siri use. The researcher coded all classrooms observation periods with teacher evidence of Siri instruction as "1," while classrooms without evidence of Siri instruction were coded as "0." Treatment classrooms coded "0" were excluded from data analysis, while control classrooms coded "1" were also excluded from data analysis.

Student Familiarity and Use Tests. The researcher analyzed survey data to determine if students' self-reported use of Siri changed during the treatment period. Students were asked to self-report if they were familiar with Siri during the EvsD administration. Students were also asked the number of times per week they utilized Siri in class and at home to help with school assignments.

Student Familiarity Data Test. The researcher analyzed and reported the percentage of students that were familiar with Siri before and after the treatment in both the treatment and control groups utilizing descriptive statistics.

Student Use Classroom Data Test. The researcher analyzed and reported changes in student-reported use of Siri for classroom assignments in school. The researcher used a *paired-samples t-test,* which was appropriate due to the existence of one categorical independent variable (sample and control) and one continuous dependent variable (number of self-reported uses of Siri per week in the classroom) (Pallant, 2007).

Student Use At-Home Data Test. The researcher analyzed and reported changes in student-reported use of Siri for classroom assignments at home. The researcher used a *paired-samples t-test,* which was appropriate due to the existence of one categorical independent variable (sample and control) and one continuous dependent variable (number of self-reported uses of Siri per week at home) (Pallant, 2007).

Assumptions For The Use of Parametric Statistical Tests. The researcher adopted parametric data analysis techniques for the student use data tests after an analysis of the type of data collected in this part of the instrument, as outlined in Pallant (2010). First, the collected data, student-reported number of Siri uses at home and at school, is made up of continuous, interval-level data, required in parametric tests. Second, students were randomly selected, as the student's classes were randomly selected to be part of either the treatment or control group. Third, the data collection model involved two independent observations of the collected data, before and after administration of the instrument. Fourth, the researcher assumed that the dependant variable in these tests, the self-reported number of Siri uses per week, would be of a normal distribution.

Student Engagement Tests. The researcher analyzed survey data to determine if student self-reported engagement via the EvdD-Student report had changed during the treatment period. The following tests were used to determine if the entire group reported changes in engagement or if all students broken down by teacher assignment reported changes in engagement.

Student Engagement Overall Test. The results of the EvsD-Student Report surveys were initially processed by reverse coding the negatively-worded items. Items in each of the four components—behavioral engagement, emotional engagement, behavioral disaffection, emotional disaffection—were then given an average score. The results of the pre- and post-survey for the control groups and treatment groups were then compared utilizing the Wilcoxon Signed Rank Test for each category, assuming an alpha level of 0.05. The Wilcoxon Signed Rank Test is an appropriate choice for the student engagement tests as it provides a test of difference of match scores (EvsD, in this case), in addition to the magnitude of differences (Pallant, 2007; Sullivan, 2016).

Student Engagement Individual Teacher Test. The results of the EvsD surveys were also broken down by the five teachers, designed by a teacher letter designation (i.e., Teacher A, Teacher B, etc.). The results of the pre- and post-survey for the control groups and treatment groups were compared utilizing the Wilcoxon Signed Rank Test for each category, assuming an alpha level of 0.05.

Student Engagement by Test Score Tests. The researcher also analyzed the 5th grade groups and the middle school groups to determine whether students categorized by high or low reading scores showed any difference in engagement. The following tests were used to determine if students broken down by reading score show differences in reported engagement.

Student Engagement High Reading Test Score Test. The results of the EvsD surveys were disaggregated by MAPS reading score. The upper third of the group were segregated, and the results of the pre- and post-survey for the control and treatment groups were compared utilizing the Wilcoxon Signed Rank Test for each category, assuming an alpha level of 0.05.

Student Engagement Low Reading Test Score Test. The results of the EvsD surveys were disaggregated by MAPS reading score. The upper third of the group were segregated, and the results of the pre- and post-survey for the control and treatment groups were compared utilizing the Wilcoxon Signed Rank Test for each category, assuming an alpha level of 0.05.

Assumptions For The Use of Nonparametric Statistics. For all tests involving the EvsD instrument question, the researcher was unable to utilize a parametric test due to to the use of Likert scale, which the researcher treated as ordinal data (Linebach et al., 2014; Norman, 2010; Triola, 2010). Pallant (2010) provides two checks to justify the use of nonparametric statistical tests, like the Wilcoxon Signed Rank Test. First, students were selected to be in the control or treatment groups via class in a random draw (Linebach et al., 2014). Second, the researcher utilized repeated measure techniques, which satisfy the requirements for independent observations (Sprent & Smeeton, 2007). Both tests were met in this research design.

Data Analysis Results

Teacher Implementation Tests. To help verify that any observed differences in reported use or engagement were, indeed, due to the treatment, the researcher developed a protocol that allowed for observation of teachers to determine the existence of direct treatment. Every class and/or class period was observed three times over the course of the study. As reported in Table 2, the researcher noted observable teacher implementation of Siri in all classes identified by the researcher for application of the treatment, as described in Chapter 3. The researcher also did not identify any instance where Siri was implemented in classes identified as control groups. Thus, the researcher included all classes in the analysis of reported use and engagement.

Table 2

Teacher Implementation Analysis Results

Teacher	Grade Level	Were observable events noted in treatment classes?	Were observable events noted in control classes?
Teacher 1	5th	Yes	N/A
Teacher 2	5th	Yes	N/A
Teacher 3	6th/8th	Yes	No
Teacher 4	7th	Yes	No
Teacher 5	8th	Yes	No

Note. The researcher was not able to to divide up 5th grade participants into a control and treatment group.

Student familiarity data test. The researcher asked students in the surveys "Are you familiar with Siri, the voice command tool, for iPhones, iPod Touches and iPads?" Table 3 summarizes the data collected from all surveyed students. The 5th grade group (n = 18) reported a decrease of overall familiarity of Siri in post surveys (from 1.00 to 0.94), through a control group was not available. Among the middle school groups (6th, 7th, and 8th grades; n = 88), the control group (n = 35) reported a decrease in familiarity in Siri (from 0.91 go 0.88), while the treatment group (n = 52) reported an increase in familiarity with Siri (from 0.88 to 0.90).

Table 3

Student Familiarity Data Test

Grade Level	n	Control/Treatment	Percentage of Students Reporting Familiarity Before	Percentage of Students Reporting Familiarity After
5th Grade	18	Treatment	100%	94%
6th Grade	13	Control	94%	84%
6th Grade	24	Treatment	95%	100%
7th Grade	13	Control	84%	84%
7th Grade	14	Treatment	78%	78%
8th Grade	9	Control	100%	100%
8th Grade	14	Treatment	85%	85%
Overall Middle School	35	Control	91%	88%
Overall Middle School	52	Treatment	88%	90%

Note. The researcher was not able to to divide up 5th grade participants into a control and treatment group.

Thus, the researcher notes an increase in the student's reported familiarity of Siri in treatment groups, while there was a decrease in the student's reported familiarity in the control groups.

Student use classroom data test. The researcher asked students in the surveys to report "Do you use Siri ever to assist with school work or assignments in class? If so, how many times per week? Otherwise, put zero." The researcher examined the 5th grade group (treatment only), and the middle school groups (treatment and control) based on the reported results. The researcher used paired-samples t-tests to analyze the results.

The researcher eliminated four surveys from analysis due to participants that reported either no number or a non-numeric number like "a lot" or "some." The researcher also compiled an average number of uses for student that reported a range (for example, "3-5 times" was analyzed as 4 times).

Table 4 details the results from these tests.

For the 5th grade (treatment) group (n = 18), a paired-samples t-test was conducted to evaluate the impact of the intervention on student participant's self-reported number of uses at school per week. There was an increase in the self-reported number of uses from pre-treatment (M = 0.5556; SD 2.3570) to post-treatment (M = 3.9722; SD = 0.100), t (17) = -2.918. However, the *p* value was 0.100, above the established *p* value threshold of 0.05, indicating there is no statistically significant difference. The eta squared statistic (0.60) indicated a large effect size (Cohen, 1988; Pallant, 2010).

For the middle school treatment group (n = 49), a paired-samples t-test was conducted to evaluate the impact of the intervention on student participant's self-reported number of uses at school per week. There was an increase in the mean of theself-reported number of uses from pre-treatment (M = 1.183; SD 3.381) to post-treatment (M = 1.265; SD = 3.200), t (48) = -0.195. However, the *p* value was 0.846, above the established *p* value threshold of 0.05, indicating there is no statistically significant difference. The eta squared statistic (0.00) indicated a no effect size (Cohen, 1988; Pallant, 2010).

In the middle school control group (n = 34), a paired-samples t-test was conducted to evaluate the impact of the intervention on student participant's self-reported number of uses at school per week. There was an decrease in the self-reported number of uses from pre-treatment (M = 3.7353; SD 17.1593) to post-treatment (M = 0.6618; SD = 1.9490), t (33) = 1.042. However, the *p* value was 0.305, above the established *p* value threshold of 0.05, indicating there is no statistically significant difference. The eta squared statistic (0.03) indicated a small effect size (Cohen, 1988; Pallant, 2010).

The researcher then reexamined the data and noted that one participant survey included a number that might be erroneous. This participant reported their weekly Siri use in the classroom at 100 times in the pre-survey, 10 times the next highest reported number, and reported no uses in their post-survey. The researcher re-calculated the test without that outlier (n = 33). With this new group, there was an decrease in the self-reported number of uses from pre-treatment (M = 0.8182; SD 2.2974) to post-treatment (M = 0.6818; SD = 1.9757), t (32) = 0.463. However, the *p* value was 0.647, above the established *p* value threshold of 0.05, indicating there is no statistically significant difference. The eta squared statistic (0.00) indicated no effect size (Cohen, 1988; Pallant, 2010).

Table 4

Student Use Classroom Data Test

	n	Mean # of Reported Uses Pre	Std. Deviation	Mean # of Reported Uses Post	Std. Deviation	Significance *p* value	t	df	Effect Size (Eta Squared)
5th Grade (Treatment)	18	0.555	2.357	3.972	7.053	0.100	-2.918	17	0.60
Middle School (Treatment)	49	1.183	3.381	1.265	3.200	0.846	-0.195	48	0.00
Middle School (Control)	34	3.735	17.159	0.661	1.949	0.305	1.042	33	0.03
Middle School (Control) Without Outlier	33	0.818	2.297	0.681	1.975	0.647	0.463	32	0.00

Note. The researcher was not able to to divide up 5th grade participants into a control and treatment group.

Student use home data test. The researcher asked students in the surveys to report "Do you use Siri ever to assist with school work or assignments **at home**? If so, how many times per week? Otherwise, put zero." The researcher examined the 5th grade group (treatment only), and the middle school groups (treatment and control) based on the reported results. The researcher used paired-samples t-tests to analyze the results.

The researcher eliminated four sets of surveys from analysis due to participants that reported either no number or a non-numeric number like "a lot" or "some." The researcher also compiled an average number of uses for student that reported a range (for example, 3-5 times was analyzed as 4 times).

Table 5 details the results from these tests.

For the 5th grade (treatment) group (n = 17), a paired-samples t-test was conducted to evaluate the impact of the intervention on student participant's self-reported number of uses at home per week. There was an increase in the self-reported number of uses from pre-treatment (M = 2.529; SD 5.896) to post-treatment (M = 3.147; SD = 7.785), t (16) = -0.448. However, the *p* value was 0.660, above the established *p* value threshold of 0.05, indicating there is no statistically significant difference. The eta squared statistic (0.01) indicated a small effect size (Cohen, 1988; Pallant, 2010).

For the middle school treatment group (n = 51), a paired-samples t-test was conducted to evaluate the impact of the intervention on student participant's self-reported number of uses at home per week. There was an increase in the self-reported number of uses from pre-treatment (M = 1.490; SD 4.501) to post-treatment (M = 1.696; SD = 2.526), t (50) = -0.346. However, the *p* value was 0.731, above the established *p* value threshold of 0.05, indicating there is no statistically significant difference. The eta squared statistic (0.00) indicated no effect size (Cohen, 1988; Pallant, 2010).

In the middle school control group (n = 33), a paired-samples t-test was conducted to evaluate the impact of the intervention on student participant's self-reported number of uses at home per week. There was a decrease in the self-reported number of uses from pre-treatment (M = 2.166; SD 5.380) to post-treatment (M = 1.575; SD = 3.789), t (32) = 0.853. However, the *p* value was 0.400, above the established *p* value threshold of 0.05, indicating there is no statistically significant difference. The eta squared statistic (0.02) indicated a small effect size (Cohen, 1988; Pallant, 2010).

Table 5

Student Use Home Data Test

	n	Mean # of Reported Uses Pre	Std. Deviation	Mean # of Reported Uses Post	Std. Deviation	Significance/ p value	t	df	Effect Size (eta squared)
5th Grade (Treatment)	17	2.529	5.896	3.147	7.785	0.660	-0.448	16	0.01
Middle School (Treatment)	51	1.490	4.501	1.696	2.526	0.731	-.346	50	0.00
Middle School (Control)	33	2.166	5.380	1.575	3.789	0.400	.853	32	0.02

Note. The researcher was not able to to divide up 5th grade participants into a control and treatment group.

Student engagement overall test. The researcher administered the *Engagement Versus Disaffection with Learning-Student Report (EvdD)* during the student survey, pre- and post-treatment. The researcher compiled results, reverse coding the negatively-worded items. Items in each of the four components—behavioral engagement, emotional engagement, behavioral disaffection, emotional disaffection—were then given an average score. Table 6 details the overall engagement results.

The researcher analyzed surveys for complete answers. Five participants did not offer evaluations for one or two statements. As the evaluation involved averaging participant responses, the researcher averaged each participant's survey based on those statements evaluated.

For the 5th grade (treatment) group (n = 18), a Wilcoxon Signed-Ranks test indicated that students reported an increased EvdD median score (pre-treatment median = 3.575; post-treatment median = 3.625), Z = 0.458. The *p* value was reported at 0.647, above the established *p* value threshold of 0.05, indicating there is no statistically significant difference. The calculated effect size (r = 0.07) indicated no effect size (Cohen, 1988; Pallant, 2010).

For the middle school treatment group (n = 52), a Wilcoxon Signed-Ranks test indicated that students reported a decreased EvsD median score (pre-treatment median = 3.400; post-treatment median = 3.350), Z = -0.123. The *p* value was reported at 0.902, above the established *p* value threshold of 0.05, indicating there is no statistically significant difference. The calculated effect size (r = 0.01) indicated no effect size (Cohen, 1988; Pallant, 2010).

For the middle school control group (n = 35), a Wilcoxon Signed-Ranks test indicated that students reported an increased EvsD median score (pre-treatment median = 3.40; post-treatment median = 3500), Z = -1.915. The *p* value was reported at 0.055 above the established *p* value threshold of 0.05, indicating there is no statistically significant difference. The calculated effect size (r = 0.02) indicated no effect size (Cohen, 1988; Pallant, 2010).

Table 6

Student Engagement Overall Test

	n	Pre Md	Post Md	Negative Ranks n	Mean Rank	Positive Ranks n	Mean Rank	Ties	Z	*p* value	Effect Size (r)
5th Grade (Treatment)	18	3.575	3.625	9	10.67	9	8.33	0	0.458	0.647	0.07
Middle School (Treatment)	52	3.400	3.350	23	25.04	25	24.00	4	-0.123	0.902	0.01
Middle School (Control)	35	3.400	3.500	12	12.54	19	19.18	4	-1.915	0.055	0.02

Note. The researcher was not able to to divide up 5th grade participants into a control and treatment group.

Student Engagement Individual Teacher Tests. The researcher tested results broken down by individual teacher, running tests on each teacher's results to analyze student-reported engagement. Table 7 details the engagement results broken down by teacher.

For teacher 1 (treatment only; n = 11), a Wilcoxon Signed-Ranks test indicated that students reported a decreased EvdD median score (pre-treatment median = 3.800; post-treatment median = 3.650), Z = -0.089. The *p* value was reported at 0.929, above the established *p* value threshold of 0.05, indicating there is no statistically significant difference. The calculated effect size (r = 0.01) indicated no effect size (Cohen, 1988; Pallant, 2010).

For teacher 2 (treatment only; n = 7), a Wilcoxon Signed-Ranks test indicated that students reported an increased EvdD median score (pre-treatment median = 3.400; post-treatment median = 3.600), Z = -0.594. The *p* value was reported at 0.553, above the established *p* value threshold of 0.05, indicating there is no statistically significant difference. The calculated effect size (r = 0.15) indicated a small effect size (Cohen, 1988; Pallant, 2010).

For teacher 3's treatment group (n = 24), a Wilcoxon Signed-Ranks test indicated that students reported an increased EvdD median score (pre-treatment median = 3.400; post-treatment median = 3.600), Z = -0.338. The *p* value was reported at 0.698, above the established *p* value threshold of 0.05, indicating there is no statistically significant difference. The calculated effect size (r = 0.05) indicated no effect size (Cohen, 1988; Pallant, 2010).

For teacher 3's control group (n = 9), a Wilcoxon Signed-Ranks test indicated that students reported a decreased EvdD median score (pre-treatment median = 3.450; post-treatment median = 3.500), Z = -0.212. The *p* value was reported at 0.034, below the established *p* value threshold of 0.05, indicating there is a statistically significant result. The calculated effect size (r = 0.04) indicated no effect size (Cohen, 1988; Pallant, 2010).

For teacher 4's treatment group (n = 14), a Wilcoxon Signed-Ranks test indicated that students reported a decreased EvdD median score (pre-treatment median = 3.350; post-treatment median = 3.325), Z = -0.267. The *p* value was reported at 0.789, above the established *p* value threshold of 0.05, indicating there is no statistically significant difference. The calculated effect size (r = 0.05) indicated no effect size (Cohen, 1988; Pallant, 2010).

For teacher 4's control group (n = 13), a Wilcoxon Signed-Ranks test indicated that students reported a decreased EvdD median score (pre-treatment median = 3.350; post-treatment median = 3.250), Z = -0.178. The *p* value was reported at 0.178, above the established *p* value threshold of 0.05, indicating there is no statistically significant difference. The calculated effect size (r = 0.03) indicated no effect size (Cohen, 1988; Pallant, 2010).

For teacher 5's treatment group (n = 14), a Wilcoxon Signed-Ranks test indicated that students reported a decreased EvdD median score (pre-treatment median = 3.325; post-treatment median = 3.300), Z = -0.316. The *p* value was reported at 0.752, above the established *p* value threshold of 0.05, indicating there is no statistically significant difference. The calculated effect size (r = 0.05) indicated no effect size (Cohen, 1988; Pallant, 2010).

For teacher 5's control group (n = 9), a Wilcoxon Signed-Ranks test indicated that students reported an increased EvsD median score (pre-treatment median = 3.500; post-treatment median = 3.650), Z = -1.131. The *p* value was reported at 0.25, above the established *p* value threshold of 0.05, indicating there is no statistically significant difference. The calculated effect size (r = 0.25) indicated a small effect size (Cohen, 1988; Pallant, 2010).

Table 7

Student Engagement Individual Teacher Tests

	n	Pre Md	Post Md	Negative Ranks n	Mean Rank	Positive Ranks n	Mean Rank	Ties	Z	Significance/ p value	Effect Size (r)
Teacher 1/5th Grade (Treatment)	11	3.800	3.650	5	6.40	6	5.67	0	-0.089	0.929	0.01
Teacher 2/5th Grade (Treatment)	7	3.400	3.600	4	4.39	3	3.50	0	-0.594	0.553	0.15
Teacher 3/6th and 8th Grade (Treatment)	24	3.400	3.450	11	12.41	13	12.59	0	-0.388	0.698	0.05
Teacher 3/6th and 8th Grade (Control)	9	3.450	3.500	1	1.50	6	4.42	2	-0.212	0.034	0.04
Teacher 4/7th Grade (Treatment)	14	3.350	3.325	5	6.0	6	6.0	3	-0.267	0.789	0.05
Teacher 4/7th Grade (Control)	13	3.350	3.250	6	5.83	5	6.20	2	-0.178	0.858	0.03
Teacher 5/8th Grade (Treatment)	14	3.325	3.300	7	7.14	6	6.83	1	-0.316	0.752	0.05
Teacher 5/8th Grade (Control)	9	3.500	3.650	4	3.25	5	6.40	0	-1.131	0.258	0.25

Note. The researcher was not able to to divide up 5th grade participants into a control and treatment group.

Student engagement by test score tests. The researcher tested results broken down by reading test score provided by the student's district. The 5th grade students had "MAP: Reading 2-5 Common Core 2010 V2" Fall 2016 results reported, while middle school students had "MAP: Reading 6+ Common Core 2010 V2" Fall 2016 results reported. The researcher analyzed the 5th grade group and middle school groups separately. The researcher ranked students by reported test score, then analyzed the top third and bottom third of each subject group based on control and treatment groups where possible. Table 8 details the results broken down by reading test score.

For the 5th grade group's bottom third test score group (treatment only; n = 6), a Wilcoxon Signed-Ranks test indicated that students reported an increased EvsD median score (pre-treatment median = 3.394; post-treatment median = 3.550), Z = -1.572. The *p* value was reported at 0.45, above the established *p* value threshold of 0.05, indicating there is no statistically significant difference. The calculated effect size (r = 0.45) indicated a medium effect size (Cohen, 1988; Pallant, 2010).

For the 5th grade group's upper third test score group (treatment only; n = 6), a Wilcoxon Signed-Ranks test indicated that students reported a decreased EvsD median score (pre-treatment median = 3.948; post-treatment median = 3.800), Z = -1.892. The *p* value was reported at 0.058, above the established *p* value threshold of 0.05, indicating there is no statistically significant difference. The calculated effect size (r = 0.54) indicated a large effect size (Cohen, 1988; Pallant, 2010).

For the middle school bottom third treatment group (n = 14), a Wilcoxon Signed-Ranks test indicated that students reported a decreased EvsD median score (pre-treatment median = 3.325; post-treatment median = 3.225), Z = -7.752. The *p* value was reported at 0.080, above the established *p* value threshold of 0.05, indicating there is no statistically significant difference. The calculated effect size (r = 1.46) indicated a large effect size (Cohen, 1988; Pallant, 2010).

For the middle school bottom third control group (n = 15), a Wilcoxon Signed-Ranks test indicated that students reported an increased EvsD median score (pre-treatment median = 3.300; post-treatment median = 3.450), Z = -0.598. The *p* value was reported at 0.550, above the established *p* value threshold of 0.05, indicating there is no statistically significant difference. The calculated effect size (r = 0.10) indicated a small effect size (Cohen, 1988; Pallant, 2010).

For the middle school upper third treatment group (n = 20), a Wilcoxon Signed-Ranks test indicated that students reported a decreased EvsD median score (pre-treatment median = 3.400; post-treatment median = 3.350), Z = -0.197. The *p* value was reported at 0.884, above the established *p* value threshold of 0.05, indicating there is no statistically significant difference. The calculated effect size (r = 0.03) indicated no effect size (Cohen, 1988; Pallant, 2010).

For the middle school upper third control group (n = 9), a Wilcoxon Signed-Ranks test indicated that students reported an increased EvsD median score (pre-treatment median = 3.200; post-treatment median = 3.225), Z = -1.550. The *p* value was reported at 0.121, above the established *p* value threshold of 0.05, indicating there is no statistically significant difference. The calculated effect size (r = 0.36) indicated a medium effect size (Cohen, 1988; Pallant, 2010).

Table 8

Student Engagement by Test Score Tests

	n	Pre Md	Post Md	Negative Ranks n	Mean Rank	Positive Ranks n	Mean Rank	Ties	Z	*p* value	Effect size (r)
5th Grade/Bottom Third/Treatment Only	6	3.394	3.550	1	3.00	5	3.60	0	-1.572	.116	0.45
5th Grade/Upper Third/Treatment Only	6	3.948	3.800	5	3.90	1	1.50	0	-1.892	.058	0.54
Middle School/Bottom Third/Treatment	14	3.325	3.225	9	7.83	4	5.13	1	-7.752	.080	1.46
Middle School/Bottom Third/Control	15	3.300	3.450	6	7.17	8	7.75	1	-0.598	.550	0.10
Middle School/Upper Third/Treatment	20	3.400	3.350	9	9.0	9	10.0	2	-0.197	.884	0.03
Middle School/Upper Third/Control	9	3.200	3.225	3	2.33	5	5.80	1	-1.550	.121	0.36

Summary

The purpose of this study was to determine if direct implementation of an intelligent personal assistant is associated with an increase in student's perception of their engagement in their classrooms. Through data analysis, the researcher found few statistically significant results to analyze; however, that does not prevent an analysis of the questions in the next chapter.

Chapter Five: Conclusions and Recommendations

In Chapter Five, there is a discussion of the findings along with conclusions derived from those findings. The conclusions from this study could have implications for teachers, technology coaches, technology directors, curriculum directors, and school administrators who are looking to integrate not only intelligent personal assistant platforms, but also any technology that purports to increase student engagement in the classroom. The findings also have implications for researchers looking into Siri or other intelligent personal assistants as an educational technology tool, and specific recommendations will be made to researchers looking conduct further research.

Determination of the Null Hypothesis

After statistical analysis, a large majority of statistical tests (23 out of 24) conducted by the researcher showed *p* value results that were above the researcher-established *p* value threshold of 0.05, concluding there were no statistically significant results in those tests. The researcher set the alpha levels for these tests apriori at 0.05. Comparisons below that *p* value will allow the researcher to reject the null hypotheses. Table 9 details the *p* values reported from individual statistical tests reported in Chapter 4.

Table 9

Study Tests and p Value

Null Hypothesis	Test Name	*p* Value	Above the Established Threshold? ($p < 0.05$)
Null Hypothesis 1_0 (Student Familiarity Data Test). The implementation of Siri and purposeful technology instruction in elementary or middle school classrooms will not increase student's self-reported familiarity with Siri.	Student Familiarity Data Tests (All)	N/A	N/A
Null *Hypothesis 2_0 (Student Use Classroom Data Test)*. The implementation of Siri and purposeful technology instruction in elementary or middle school classrooms will not increase student's self-reported weekly use of Siri to complete classroom assignments in school.	Student Use Classroom Data Test (5th Treatment)	0.100	No
	Student Use Classroom Data Test (Middle School Treatment)	0.846	No
	Student Use Classroom Data Test (Middle School Control)	0.305	No
	Student Use Classroom Data Test (Middle School Control without Outlier)	0.647	No
Null *Hypothesis 3_0 (Student Use At Home Data Test)*. The implementation of Siri and purposeful technology instruction in elementary or middle school classrooms will not increase student's self-reported weekly use of Siri to complete classroom assignments at home.	Student Use Home Data Test (5th Grade Treatment)	0.660	No
	Student Use Home Data Test (Middle School Treatment)	0.731	No
	Student Use Home Data Test (Middle School Control)	0.400	No
Null *Hypothesis 4_0 (Student Engagement Overall Test)*. The implementation of Siri and purposeful technology instruction in elementary or middle school science classrooms will not increase student engagement in the classroom, as measured by the *Engagement Versus Disaffection with Learning-Student Report* instrument.	Student Engagement Overall Test (5th Grade Treatment)	0.647	No
	Student Engagement Overall Test (Middle School Treatment)	0.902	No
	Student Engagement Overall Test (Middle School Control)	0.055	No

(continued)

Study Tests and p Value (Continued)

Null Hypothesis	Test Name	*p* Value	Above the Established Threshold? ($p < 0.05$)
Null *Hypothesis 5_0 (Student Engagement Individual Teacher Test)*. The implementation of Siri and purposeful technology instruction in elementary or middle school science classrooms will not increase student engagement in an individual teacher's classroom, as measured by the *Engagement Versus Disaffection with Learning-Student Report* instrument.	Student Engagement Individual Teacher Test (Teacher 1 Treatment)	0.929	No
	Student Engagement Individual Teacher Test (Teacher 2 Treatment)	0.553	No
	Student Engagement Individual Teacher Test (Teacher 3 Treatment)	0.698	No
	Student Engagement Individual Teacher Test (Teacher 3 Control)	0.034	Yes
	Student Engagement Individual Teacher Test (Teacher 4 Treatment)	0.789	No
	Student Engagement Individual Teacher Test (Teacher 4 Control)	0.858	No
	Student Engagement Individual Teacher Test (Teacher 5 Treatment)	0.752	No
	Student Engagement Individual Teacher Test (Teacher 5 Control)	0.258	No
Null *Hypothesis 6_0 (Student Engagement High Reading Test Score Test)*. The implementation of Siri and purposeful technology instruction in elementary or middle school science classrooms will not increase student engagement for students with the highest third of reading scores, as measured by the *Engagement Versus Disaffection with Learning-Student Report* instrument. Null *Hypothesis 7_0 (Student Engagement Low Reading Test Score Test)*. The implementation of Siri and purposeful technology instruction in elementary or middle school science classrooms will not increase student engagement for students with the lowest third of reading scores, as measured by the *Engagement Versus Disaffection with Learning-Student Report* instrument.	Student Engagement by Test Score Test (5th Grade Bottom Third Treatment)	.116	No
	Student Engagement by Test Score Test (5th Grade Top Third Treatment)	.058	No
	Student Engagement by Test Score Test (Middle School Bottom Third Treatment)	.080	No
	Student Engagement by Test Score Test (Middle School Bottom Third Control)	.550	No
	Student Engagement by Test Score Test (Middle School Top Third Treatment)	.884	No
	Student Engagement by Test Score Test (Middle School Top Third Control)	.121	No

The researcher adopted a cautious approach in the analysis of this data after a review of guidance from researchers and statisticians. Thompson (1993) argues that researchers (and particularly dissertation writers) should be cautious at the use of significance testing in rejecting null hypotheses, warning that null hypothesis statements are sometimes rejected without evidence to do so. Hankins (2013) dissuades researchers from attempting to make their research results more "interesting" by adopting inflated rhetoric, while others note that traditionally null hypotheses can be inappropriately rejected with statistically significant results (Lane, 2013).

Null Hypothesis 1_0 (Student Familiarity Data Test). The researcher evaluated the null hypothesis "The implementation of Siri and purposeful technology instruction in elementary or middle school classrooms will not increase student's self-reported familiarity with Siri." utilizing the "Student Familiarity Data Test" that was initially proposed in this study.

As detailed in Chapter 4, the 5th grade treatment group reported a slight decrease in familiarity with Siri (100% to 94%), while the middle school treatment group reported slight increase in familiarity (88% to 90%). The middle school control group reported a slight decrease in familiarity (91% to 88%). When broken down into grade levels, the 5th and 6th grade groups showed variability in reports of familiarity, while the 7th and 8th grade groups reported the same familiarity.

As descriptive statistics do not provide a determination of the null hypothesis, there is no standard practice on evaluating a null hypothesis. However, with four out of seven tests showing no difference in student familiarity and the remaining showing inconsistent results, there is no evidence that the null should be rejected.

Null Hypothesis 2_0 (Student Use Classroom Data Test). The researcher evaluated the null hypothesis, "The implementation of Siri and purposeful technology instruction in elementary or middle school classrooms will not increase student's self-reported weekly use of Siri to complete classroom assignments in school" utilizing the "Student Use Classroom Data Tests" that were initially proposed in this study.

As detailed in Chapter 4, the 5th grade group reported an increase in the mean of the group (pre = 0.555; post; 3.972), however, with a *p* value of 0.100, above the threshold established by the researcher. The researcher also calculated an effect size of 0.60 via an eta squared, which is considered a large effect size (Cohen, 1988; Pallant, 2010).

The researcher considered the middle school statistical results, comparing control and treatment groups. The researcher used the statistical results from the control group without the outlier as described in Chapter 4. The treatment group participants reported increased in-class use (1.183 to 1.265), while the control group reported decreased in-class use (0.818 to 0.681). Both tests showed *p* values above the established threshold of 0.05 (0.846 and 0.647 respectively), indicating no significant difference. The researcher also computed an effective size of 0.00 for both tests, indicating no effect size (Cohen, 1988; Pallant, 2010).

Although there is evidence of an impact of the treatment in the 5th grade classrooms, there was no control group available to determine to compare results. Though the middle school group shows an increase and decrease among treatment and control groups, respectively, the lack of statistically significant results and no effect side do not present persuasive evidence to reject the null hypothesis.

Null Hypothesis 3_0 (Student Use At Home Data Test). The researcher evaluated the null hypothesis, "The implementation of Siri and purposeful technology instruction in elementary or middle school classrooms will not increase students' self-reported weekly use of Siri to complete classroom assignments at home," utilizing the "Student Use At Home Data Tests" that were initially proposed in this study.

As described in Chapter 4, both the 5th grade and middle school treatment groups reported an increase in use at home (5th grade, 2.529 to 3.147; middle school, 1.490 to 1.696), although with statistically insignificant reports (5th grade, $p = 0.660$; middle school, $p = 0.731$).

The middle school control group reported a decrease in the number of uses at home (2.166 to 1.575), though with a statistically insignificant result (p = 0.400).

The researcher also calculated an effect size, resulting in a report of small effective sizes in the treatment groups (5th grade = 0.01; middle school = 0.02), and a small effective size in the control group (0.02). Taken together, the lack of statistically significant results and low effect sizes do not present persuasive evidence to reject the null hypothesis.

Null Hypothesis 4_0 (Student Engagement Overall Test). The researcher evaluated the null hypothesis, "The implementation of Siri and purposeful technology instruction in elementary or middle school science classrooms will not increase student engagement in the classroom, as measured by the *Engagement Versus Disaffection with Learning-Student Report* instrument," utilizing the "Student Engagement Overall Test" that was initially proposed in this study.

As described in Chapter 4, the 5th grade group reported an increase in engagement in the EvdD survey instrument (pre = 3.575; post = 3.625), though with statistically insignificant results (p = 0.647). The researcher computed an effect side (r = 0.07), which is considered to be no effect size (Cohen, 1988; Pallant, 2010).

The middle school groups showed a decrease in reported engagement among the treatment group (pre = 3.400; post = 3.350), and an increase in reported engagement among the control group (pre = 3.400; post = 3.500). These tests reported significance values below the established threshold of 0.05 (treatment = 0.647; control = 0.005). The researcher computed effect sizes with results (treatment = 0.01; control = 0.02) denoting no effect size (Cohen, 1988; Pallant, 2010).

Although there was an increase in the reported engagement in the 5th grade group, the results were not statistically significant and with no effect size. Among the middle school group, the treatment group showed a *decrease* in engagement, while the control group showed an *increase* in engagement, both with no effect sizes. Taken together, these results do not present persuasive evidence to reject the null hypothesis.

Null Hypothesis 5_0 (Student Engagement Individual Teacher Test). The researcher evaluated the null hypothesis, "The implementation of Siri and purposeful technology instruction in elementary or middle school science classrooms will not increase student engagement in an individual teacher's classroom, as measured by the *Engagement Versus Disaffection with Learning-Student Report* instrument," utilizing the "Student Engagement Individual Teacher Test" that was initially proposed in this study.

As described in Chapter 4, only one of the eight tests conducted demonstrated significantly significant results. Teacher 3's *control group* showed an increase in engagement (pre = 3.450; post = 3.500; p = 0.034). However, the researcher calculated an effect size that suggested no effect size (r = 0.04) (Cohen, 1988; Pallant, 2010). This would suggest that the researcher should not reject the null.

The researcher found two instances where effect sizes were at a minimum standard of small effect (Cohen, 1988; Pallant, 2010). Teacher 2 (treatment) showed an increase of reported engagement (pre = 3.400; post = 3.600; p = 0.553; r = 0.15), while Teacher 5's control group showed an increase of reported engagement (pre = 3.500; post = 3.650; p = 0.258; r = 0.25). This would suggest that the researcher should not reject the null.

The remaining tests report back statistically insignificant results with no effect sizes. Taken together, these results do not present persuasive evidence to reject the null hypothesis.

Null Hypothesis 6_0 (Student Engagement High Reading Test Score Test). The researcher evaluated the null hypothesis, "The implementation of Siri and purposeful technology instruction in elementary or middle school science classrooms will not increase student engagement for students with the highest third of reading scores, as measured by the *Engagement Versus Disaffection with Learning-Student Report* instrument," utilizing the "Student Engagement by Test Score Test" that was initially proposed in this study.

Among the treatment groups, both the 5th grade and middle school groups posted *decreased* engagement scores (5th grade: pre = 3.948; post = 3.800; middle school: pre = 3.400; post = 3.350), though with *p* value values below the established threshold of 0.05. The researcher calculated effect sizes. The 5th grade treatment group had a report of a large effect (r = 0.54), while the middle school group had no effect size (r = 0.03) (Cohen, 1988; Pallant, 2010).

Among the control group (middle school only), participants reported *increased* engagement scores (pre = 3.200; post = 3.225), though the *p* values were below the established threshold of 0.05. The researcher calculated effect size, with the effect size (r = 0.36) reflecting a medium effect size (Cohen, 1988; Pallant, 2010).

Though not statistically significant, the results of these tests show that the treatment protocol is associated with *decreased* engagement among students with the highest third reading scores; thus, there is no persuasive evidence to reject the null.

Null Hypothesis 7_0 (Student Engagement Low Reading Test Score Test). The researcher evaluated the null hypothesis, "The implementation of Siri and purposeful technology instruction in elementary or middle school science classrooms will not increase student engagement for students with the lowest third of reading scores, as measured by the

Engagement Versus Disaffection with Learning-Student Report instrument," utilizing the "Student Engagement by Test Score Test" that was initially proposed in this study.

Among the treatment groups, students showed mixed results. The 5th grade treatment group showed an *increase* in engagement (pre = 3.394; post = 3.550), though the *p* value (0.116) is below threshold of 0.05 established by the researcher. The middle school treatment group showed a *decrease* in engagement (pre = 3.325; post = 3.225, with the *p* value (0.080) also reported below the establish threshold of 0.05. The researcher also calculated effect sizes with the elementary group showing a medium effect size (r = 0.45) and the middle school group showing a large effect size (r = 1.46) (Cohen, 1988; Pallant, 2010).

The control group (middle school only) reported increased engagement (pre = 3.330; post = 3.450), with significance (0.550) reporting below the 0.05 threshold established by the researcher. The researcher calculated the effect size at 0.10, suggesting a small effect size (Cohen, 1988; Pallant, 2010).

This test provided conflicting results. The 5th grade group does suggest that participants that had the bottom third of reading scores did report an increase in engagement with the treatment with a medium effect size. However, the test did not prove statistically significant and the researcher was not able to utilize a control group with the 5th grade students, making this less persuasive in rejecting the null. The middle school groups mirrored the high reading score tests, where the treatment group showed lower engagement and the control group showed higher engagement, leaving no persuasive evidence to reject the null.

Findings

The researcher proposed a null hypothesis of, "The implementation of Siri with purposeful technology instruction in elementary or middle school classrooms will not increase student engagement in the classroom, as measured by the Engagement Versus Disaffection with Learning-Student Report instrument." Through analysis of the sub-null hypotheses, the researcher was not able to reject any with statistically significant results from the data, including an examination of effect size. Though there was some statistically insignificant evidence that students in treatment groups increased their reported use of Siri both in the classroom and at home, that is not associated with increased student reports of engagement. That held true in overall tests, tests broken down by teachers, and in all but one of the tests conducted based on reading scores. Thus, the researcher concludes that he cannot reject the null hypothesis.

Overall, the study results suggests that Siri is not associated with increases in student engagement in 5th grade and middle school science classrooms. In reviewing literature cited in Chapter 2, the findings are consistent with other research findings reported there.

Intelligent personal assistants. Although the researcher did not examine student participant's particular use of the Siri beyond informal observation, Moore (2016) noted that end users may find intelligent personal assistants difficult to adopt as their use requires adapting human language to find a functional vocabulary. The researcher did find statistically insignificant evidence that use itself increased; however, the lack of evidence of increased engagement could reflect that adoption curve.

Since the review of research was conducted, the popular technology press has reported that the specific intelligent personal assistant utilized in the treatment of this study, Siri, is lagging substantially in the marketplace. Echoing authors like Moore (2016), Apple has been accused of letting Siri fall behind market competitors like Alexa (Amazon) and Google Assistant (Google) (Simonite et al., 2017). Due to the quickly changing consumer electronics environment, companies like Apple need tools like Siri to "constantly be updated" to stay up with competitors, something that has not happened (Wong, 2018). Apple has released products in the last two years in an attempt to be competitive in this market space; however, former Apple employees cited in popular technology media say that is not enough to make Siri competitive against rivals (Lovejoy, 2017). Critics evaluating Apple new “smart speaker,” the HomePod, praise sound quality but note that Siri is not as functional as other alternatives in the marketplace (Reisinger, 2018) and in some tests, proved to be inaccurate in providing answers to content questions (Munster, 2018).

Beyond Siri, the Alexa platform has become the dominant market leader, with more than 70% of all intelligent personal assistant-enabled devices (other than phones) running the Alexa platform (Griswold, 2018). As the market leader, it is beginning to become the focus of popular education media, with recent articles focusing on the impact of Alexa on language and conversation (Bouffard, 2018) along with consumer privacy (Pullen, 2017).

Educational technology. The findings of this study provide additional evidence technology itself is not always engaging and that implementation alone will not bring engagement (Donovan, Green, & Harley, 2010). As intelligent personal assistants are clearly a highly-desired technology based on market research cited above, one might presume that its inclusion and acceptance in the classroom environment will bring increases in positive outcomes like student engagement. The results of this study call that assumption into question.

Recommendations for Future Study

This study inspires a number of questions that the researcher hopes will be fodder for future study, discussion, and reflection. As intelligent personal assistants grow in availability and functionality on our phones, tablets, computers, and, now, smart speakers, there will likely be many opportunities in the future to look at these platforms in a variety of educational contexts.

This study could be replicated in different contexts. The researcher was limited to students and parents who opted into the study, risking the generalizability of the results (Kukull & Ganguli, 2012). A research design that involves finding a school that is considering implementing Siri on its own and looking for external validation might bring a larger sample of participants, randomly selected, that could provide more evidence on the issue. As noted earlier, this study was limited to one school in Montana. Future researchers could look at urban schools or larger or smaller schools to see if integration of an intelligent personal assistant platform impacts engagement elsewhere.

Researchers might also consider using another intelligent personal assistant platform to evaluate instead of Siri. Although Siri was chosen by the research in part due to the availability of a participating school that had one-to-one student availability to the platform, other intelligent personal assistants are now widely available that can be rolled out in a variety of devices. For example, since this study began, Microsoft's Cortana is now widely available outside of Windows 10 computers and Windows mobile devices, including implementations on Apple's iOS (Ong, 2018) and Google's Android (Nield, 2017) platforms.

The measure of engagement itself might provide future researchers different approaches to the questions broached in this study. As discussed earlier, older students report lower engagement levels than younger students, with data suggesting that it wanes in middle school and high school (Marks, 2000). Further research to see if implementation of the platform is associated with any changing outcomes for students who are already substantially disengaged and in need of direct engagement strategies is warranted.

Future research should also look at engagement more longitudinally, taking multiple measures of engagement over time, as in the Hur & Oh (2012) research discussed in Chapter 2. The researcher in this study took a pre- and post-survey of students; however, the instrument used here could be delivered on a more frequent schedule to see if there is an ebb and flow of reported engagement over time.

Researchers, too, might also consider looking at different measures to determine impacts of implementation of an intelligent personal assistant in the classroom. Standardized test scores, student perception surveys, student attendance rates, student on-task measures, teacher satisfaction, school climate, student agency, and other measures or considerations might provide new insights on this discussion.

Finally, there was one specific test result that merits further research. As reported in Chapter 4, the "Student Engagement by Test Score" test yielded a result suggesting increased engagement that suggests further examination. Students in the 5th grade group with the lowest third of reading scores ($n = 6$) showed an increase in reported engagement (pre = 3.394, post = 3.550), with evidence of moderate effect size ($r = 0.45$). This evidence wasn't enough to reject the null hypothesis as it didn't meet the significance threshold established by the researcher, and the researcher was unable to create a control group to compare results. It also wasn't replicated in the middle school group, which did have a treatment and control group available. Future researchers should consider aiming attention at intelligent personal assistants used as a strategy to assist younger students with lower reading levels.

Recommendations for Practitioners

Broadly, classroom teachers should expect intelligent personal assistants to become a greater factor in classrooms, based on the fast adoption rate of the platform in consumer markets. The technology is available on all modern-day mobile devices and may be a tool that students look to for answering questions or providing insight. The researcher recommends that teachers continue to examine the marketplace, testing out new technologies and considering what impact they may have on their students, content assignments, and teaching strategies.

Specifically from the results of this research, teachers, administrators, and policymakers should show caution in adopting technologies as an engagement strategy. The results of this research are congruent with those cited in Chapter 2 that note that the relationship between technology and learning is too complex to make broad assumptions about the integration of technology (Donovan, Green, & Hartley, 2010) and that we need more evidence of the impact of specific technologies on engagement and related measures (Arnone et al., 2011). As more evidence is available on specific technologies like intelligent personal assistants, practitioners should weigh available data and research when making purchasing and integration decisions.

Intelligent personal assistants should also be approached with caution. The results of this research suggest that there is no clear association between integration of Siri in 5th grade/middle school science classrooms and increases of student engagement. Practitioners should be cautious to integrate an intelligent personal assistant based on justifications of increasing student engagement. This is especially important considering recent developments related to other factors that are impacted by the use of these devices. Early concerns about the impact of intelligent personal assistants on language and communication (Bouffard, 2018) along with data and privacy (Bates, 2014; Damopoulos et al., 2012) justify a caution approach.

Finally, practitioners should consider looking at intelligent personal assistants as a targeted intervention. As discussed earlier, there is some suggestion that Siri might have some impact on younger students with lower reading scores. The data analysis did not provide statistically significant results to provide direct guidance to practice; however, as these tools evolve, teachers and administrators might consider looking at targeted experiments utilizing these tools with students that struggle with reading. The researcher recommends that practitioners pair up with educational researchers and future dissertation writers to help add to the body of researchers.

Conclusion

The last 40 years have seen the introduction of an extraordinary and quickly-evolving toolset into our society, and ultimately into education and our classrooms. At no other time in history have we witnessed such a dramatic evolution in the way we acquire information, interact with one another, and create for others than we have in the era of computers and, more recently, mobile devices. It is in this landscape that schools are searching far and wide for strategy to increase engagement.

Intelligent personal assistants are one of the byproducts of this changing landscape. As phones and other mobile devices become smaller and connected to more and more devices via the Internet, technology companies are finding that the human voice can be a powerful means of interacting with our devices, whether it is to command these devices to complete tasks or provide insights to questions big or small.

This study examined these tools through the lens of engagement. While this study found no evidence to suggest that implementation of these tools in classrooms positively impacts engagement, the researcher hopes that future researchers and practitioners will continue to examine this and other technology innovations together to help inform best practices. The seemingly magical wonder that often accompanies the introduction and adoption of digital-era technologies must always be tempered with careful study and implementation.

References

7 Pros And Cons Of Using Siri For Learning. (2012, December 7). Retrieved March 11, 2016, from http://www.teachthought.com/uncategorized/7-pros-and-cons-of-using-siri-for-learning/

Apple, Inc. (n.d.). iOS - Siri - Apple. Retrieved July 5, 2016, from http://www.apple.com/ios/siri/

Apple's iPad remains dominant in shrinking tablet market. (2015, April 30). Retrieved October 24, 2016, from http://appleinsider.com/articles/15/04/30/apples-ipad-remains-dominant-in-shrinking-tablet-market

Appleton, J. J., Christenson, S. L., & Furlong, M. J. (2008). Student engagement with school: Critical conceptual and methodological issues of the construct. *Psychology in the Schools*, *45*(5), 369–386.

Appleton, J. J., Christenson, S. L., Kim, D., & Reschly, A. L. (2006). Measuring cognitive and psychological engagement: Validation of the Student Engagement Instrument. *Journal of School Psychology*, *44*(5), 427–445.

Arnone, M. P., Small, R. V., Chauncey, S. A., & McKenna, P. H. (2011). Curiosity, interest and engagement in technology-pervasive learning environments: a new research agenda. *Educational Technology Research and Development: ETR & D*, *59*(2), 181–198.

Aron, J. (2011, October 26). How innovative is Apple's new voice assistant, Siri? *New Scientist*. Retrieved from https://www.newscientist.com/article/mg21228365-300-how-innovative-is-apples-new-voice-assistant-siri/

Assefi, M., Liu, G., Wittie, M. P., & Izurieta, C. (2015). An Experimental Evaluation of Apple Siri and Google Speech Recognition. *Proceedings of the 2015 ISCA SEDE*. Retrieved from http://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.706.5567&rep=rep1&type=pdf

Assor, A. (2012). Allowing choice and nurturing an inner compass: Educational practices supporting students' need for autonomy. *Handbook of Research on Student Engagement*. Retrieved from http://link.springer.com/chapter/10.1007/978-1-4614-2018-7_20

Barlowe, A., & Cook, A. (2016, Spring). Putting the Focus on Student Engagement. *American*

Educator. Retrieved from http://www.aft.org/ae/spring2016/barlowe-and-cook

Bates, P. (2014, October 21). Do Siri, Cortana & Google Now Need Too Much Personal Data? Retrieved from http://www.makeuseof.com/tag/siri-cortana-google-now-need-much-personal-data/

Beeland, W. D. (2002). Student engagement, visual learning and technology: Can interactive whiteboards help. Presented at the Annual Conference of the Association of Information Technology for Teaching Education, Trinity College, Dublin. Retrieved from http://www.academia.edu/download/38455890/COOOOL.pdf

Beland, L.-P., & Murphy, R. (2015, Summer). In brief... Phone home: should mobiles be banned in schools? Retrieved July 9, 2016, from http://cep.lse.ac.uk/BREXIT/abstract.asp?index=4694

Bledsoe, T. S. (2013). A Multimedia-Rich Platform to Enhance Student Engagement and Learning in an Online Environment. *Online Learning Journal*. Retrieved from http://olj.onlinelearningconsortium.org/index.php/olj/article/view/398

Block, J. (2013, October 1). Planning for Engagement: 6 Strategies for the Year. Retrieved July 9, 2016, from http://www.edutopia.org/blog/planning-for-engagement-6-strategies-joshua-block

Bohn, D. (2016, May 18). Google is making its assistant “conversational” in two new ways. Retrieved July 9, 2016, from http://www.theverge.com/2016/5/18/11672938/google-assistant-chatbot-virtual-assistant-io-2016

Bosse, T., Duell, R., Hoogendoorn, M., Klein, M., van Lambalgen, R., van der Mee, A., … de Vos, M. (2009). A Generic Personal Assistant Agent Model for Support in Demanding Tasks. In D. D. Schmorrow, I. V. Estabrooke, & M. Grootjen (Eds.), *Foundations of Augmented Cognition. Neuroergonomics and Operational Neuroscience* (pp. 3–12). Springer Berlin Heidelberg.

Bouffard, S. (2018, March 21). Hey, Alexa, What Are You Teaching Our Kids? Retrieved March 29, 2018, from https://www.kqed.org/mindshift/50781

Brandom, R. (2016, May 18). The 10 biggest announcements from Google I/O 2016. Retrieved September 19, 2016, from http://www.theverge.com/2016/5/18/11701030/google-io-2016-

keynote-highlights-announcements-recap

Brenner, L. (2015, October 27). 3 ways to increase student engagement in your classroom. Retrieved April 20, 2016, from https://www.iste.org/explore/articleDetail?articleid=590&category=Innovator-solutions&article=

Broeckelman-Post, M., Johnson, A., & Schwebach, J. R. (2016). Calling on Students Using Notecards: Engagement and Countering Communication Anxiety in Large Lecture. *Journal of College Science Teaching*, *045*(05). https://doi.org/10.2505/4/jcst16_045_05_27

Calkins, K., & Bowles-Terry, M. (2013). Mixed Methods, Mixed Results: A Study of Engagement among Students Using iPads in Library Instruction. Presented at the Imagine, Innovate, Inspire: The Proceedings of the ACRL 2013 National Conference. Retrieved from http://www.ala.org/acrl/sites/ala.org.acrl/files/content/conferences/confsandpreconfs/2013/papers/Calkins_Mixed.pdf

Chen, P.-S. D., Lambert, A. D., & Guidry, K. R. (2010). Engaging online learners: The impact of Web-based learning technology on college student engagement. *Computers & Education*, *54*(4), 1222–1232.

Christenson, S. L., Reschly, A. L., & Wylie, C. (2012). *Handbook of Research on Student Engagement*. Springer New York.

Cohen, J. (1988). Statistical power analysis for the behavioral sciences 2nd edn. Erlbaum Associates, Hillsdale.

Committee on Increasing High School Students' Engagement and Motivation to Learn, Board on Children, Youth and Families, Division of Behavioral and Social Sciences and Education, & National Research Council. (2003). *Engaging Schools: Fostering High School Students' Motivation to Learn*. National Academies Press.

Cooper, R. S., McElroy, J. F., Rolandi, W., Sanders, D., Ulmer, R. M., & Peebles, E. (2004, June 29). *6757362*. *US Patent*. USPTO. Retrieved from https://www.google.com/patents/US6757362

Creswell, J. W. (2009). *Research Design Qualitative, Quantitative, and Mixed Methods Approaches*

(3rd ed.). Sage Publications.

Dale, R. (2015). The limits of intelligent personal assistants. *Natural Language Engineering*, *21*(02), 325–329.

Damopoulos, D., Kambourakis, G., Anagnostopoulos, M., Gritzalis, S., & Park, J. H. (2012). User privacy and modern mobile services: are they on the same path? *Personal and Ubiquitous Computing*, *17*(7), 1437–1448.

DeWitt, P. (2016, April 12). Student Engagement: Is It Authentic or Compliant? Retrieved September 18, 2016, from http://blogs.edweek.org/edweek/finding_common_ground/2016/04/student_engagement_is_it_authentic_or_compliant.html

Donovan, L., Green, T., & Hartley, K. (2010). An Examination of One-to-One Computing in the Middle School: Does Increased Access Bring about Increased Student Engagement? *Journal of Educational Computing Research*, *42*(4), 423–441.

Eadicicco, L. (2016, July 1). Apple Finally Put Siri Where It Belongs. *Time*. Retrieved from http://time.com/4391290/apple-siri-mac-desktop-laptop/

Empson, R. (2011b, July 29). Three Companies Chi-Hua Chien Of Kleiner Perkins Would Love To Invest In. Retrieved April 20, 2016, from http://social.techcrunch.com/2011/07/29/three-companies-chi-hua-chien-of-kleiner-perkins-would-love-to-invest-in/

Finley, T. (2014, August 25). New Study: Engage Kids With 7x the Effect. Retrieved August 2, 2016, from http://www.edutopia.org/blog/engage-with-7x-the-effect-todd-finley

Finn, J. D. (1989). Withdrawing From School. *Review of Educational Research*, *59*(2), 117–142.

Finn, J. D., & Owings, J. (2006). *The Adult Lives of At-risk Students: The Roles of Attainment and Engagement in High School--statistical Analysis Report*. National Center for Education Statistics. Retrieved from http://www.voced.edu.au/content/ngv:35635

Finn, J. D., & Zimmer, K. S. (2012). Student Engagement: What Is It? Why Does It Matter? In S. L. Christenson, A. L. Reschly, & C. Wylie (Eds.), *Handbook of Research on Student Engagement* (pp. 97–131). Springer US.

Foley, M. J. (2014, March 4). Microsoft's "Cortana" alternative to Siri makes a video debut. *ZDNet*. Retrieved from http://www.zdnet.com/article/microsofts-cortana-alternative-to-siri-makes-a-video-debut/

Fowler, G. A. (2016, June 14). Siri: Once a Flake, Now Key to Apple's Future. *Wall Street Journal Online*. Retrieved from http://www.wsj.com/articles/siri-once-a-flake-now-key-to-apples-future-1465905601

Fredricks, J., Blumenfeld, P. C., & Paris, A. H. (2004). School Engagement: Potential of the Concept, State of the Evidence. *Review of Educational Research*, *74*(1), 59–109.

Fredricks, J., & McColskey, W. (2012). The Measurement of Student Engagement: A Comparative Analysis of Various Methods and Student Self-report Instruments. In S. L. Christenson, A. L. Reschly, & C. Wylie (Eds.), *Handbook of Research on Student Engagement* (pp. 763–782). Springer US.

Fredricks, J., McColskey, W., Meli, J., Mordica, J., Montrosse, B., & Mooney, K. (2011). *Measuring Student Engagement in Upper Elementary through High School: A Description of 21 Instruments*. REL Southeast. Retrieved from http://files.eric.ed.gov/fulltext/ED514996.pdf

Future of Privacy Forum. (n.d.). Signatories – Pledge to Parents & Students. Retrieved September 2, 2016, from https://studentprivacypledge.org/signatories/

Gong, L. (2003, September 4). *20030167167:A1*. *US Patent*. USPTO. Retrieved from https://www.google.com/patents/US20030167167

Griswold, A. (2018, February 4). Even Amazon is surprised by how much people love Alexa. Retrieved March 29, 2018, from https://qz.com/1197615/even-amazon-is-surprised-by-how-much-people-love-alexa/

Hankins, M. (2013, April 21). Still Not Significant. Retrieved March 28, 2018, from https://mchankins.wordpress.com/2013/04/21/still-not-significant-2/

Hipkins, R. (2012). The Engaging Nature of Teaching for Competency Development. In S. L.

Christenson, A. L. Reschly, & C. Wylie (Eds.), *Handbook of Research on Student Engagement* (pp. 441–456). Springer US.

Hur, J. W., & Oh, J. (2012). Learning, Engagement, and Technology: Middle School Students' Three-Year Experience in Pervasive Technology Environments in South Korea. *Journal of Educational Computing Research*, *46*(3), 295–312.

Hur, J. W., Shannon, D., & Wolf, S. (2016). An Investigation of Relationships Between Internal and External Factors Affecting Technology Integration in Classrooms. *Journal of Digital Learning in Teacher Education*, *32*(3), 105–114.

Hutchison, A., Beschorner, B., & Schmidt-Crawford, D. (2012). Exploring the Use of the iPad for Literacy Learning. *The Reading Teacher*, *66*(1), 15–23.

Jimenez, A. (2015, August 3). 3 Strategies To Integrate Technology, Increase Student Engagement, & Impact Overall Student Achievement. *Illuminate Education Blog*. Retrieved from https://www.illuminateed.com/blog/2015/08/3-strategies-to-integrate-technology-increase-student-engagement-impact-overall-student-achievement/

Junco, R. (2012/1). The relationship between frequency of Facebook use, participation in Facebook activities, and student engagement. *Computers & Education*, *58*(1), 162–171.

Junco, R., Heiberger, G., & Loken, E. (2011). The effect of Twitter on college student engagement and grades. *Journal of Computer Assisted Learning*, *27*(2), 119–132.

Kagan, S. (2010). Disengagement: Achievement Gaps, Discipline, and Dropout - Treating the Disease, Not Just the Symptoms. Retrieved July 11, 2016, from http://www.kaganonline.com/free_articles/dr_spencer_kagan/262/Disengagement-Achievement-Gaps-Discipline-and-Dropout-Treating-the-Disease-Not-Just-the-Symptoms,2

Khosla, V., Huang, D., & Andrus, S. (2016, June). Extending Your Apps with SiriKit. Retrieved July 9, 2016, from https://developer.apple.com/videos/play/wwdc2016/225/

Klem, A. M., & Connell, J. P. (2004). Relationships matter: linking teacher support to student engagement and achievement. *The Journal of School Health*, *74*(7), 262–273.

Knowledge Navigator. (1987). [YouTube]. United States of America: Apple Inc. Retrieved from https://www.youtube.com/watch?v=umJsITGzXd0

Kukull, W. A., & Ganguli, M. (2012). Generalizability: the trees, the forest, and the low-hanging fruit. *Neurology*, *78*(23), 1886–1891.

Kuntz, B. (2012, June). Engage Students by Embracing Technology. *Education Update*, *54*(6). Retrieved from http://www.ascd.org/publications/newsletters/education-update/jun12/vol54/num06/Engage-Students-by-Embracing-Technology.aspx

Laird, T., & Kuh, G. D. (2005). Student experiences with information technology and their relationship to other aspects of student engagement. *Research in Higher Education*. Retrieved from http://link.springer.com/article/10.1007/s11162-004-1600-y

Lane, D. M. (2013). *Introduction to Statistics* (2nd ed.). Houston, TX: Rice University.

Limrick, K., Lambert, A., & Chapman, E. (2014). *Cellular Phone Distracted Driving: A Review of the Literature and Summary of Crash and Driver Characteristics in California*. California Department of Motor Vehicles. Retrieved from http://www.dmv.ca.gov/portal/wcm/connect/08ac48df-b006-4f3e-aa97-04f4f9682a66/S7-248.pdf?MOD=AJPERES

Linebach, J. A., Tesch, B. P., & Kovacsiss, L. M. (2014). Nonparametric statistics for applied research. Retrieved from http://link.springer.com/content/pdf/10.1007/978-1-4614-9041-8.pdf

Lopez, S. (2014, April 10). Not Enough Students Are Success-Ready. *Gallup Business Journal*. Retrieved from http://www.gallup.com/businessjournal/168242/not-enough-students-success-ready.aspx

Lovejoy, B. (2017, June 8). Siri still lagging behind IA rivals despite HomePod & iOS 11 upgrades, say ex-employees & developers. Retrieved March 29, 2018, from https://9to5mac.com/2017/06/08/siri-still-lagging-behind-ia-rivals-despite-homepod-ios-11-upgrades-say-ex-employees-developers/

Manlove, J. (1998). The influence of high school dropout and school disengagement on the risk of school-age pregnancy. *Journal of Research on Adolescence: The Official Journal of the Society for Research on Adolescence*, *8*(2), 187–220.

Marks, H. M. (2000). Student Engagement in Instructional Activity: Patterns in the Elementary, Middle, and High School Years. *American Educational Research Journal*, *37*(1), 153–184.

Martin, A. J. (2006). The Relationship Between Teachers' Perceptions of Student Motivation and Engagement and Teachers' Enjoyment of and Confidence in Teaching. *Asia-Pacific Journal of Teacher Education*, *34*(1), 73–93.

McHarg, J., Kay, E. J., & Coombes, L. R. (2012). Students' engagement with their group in a problem-based learning curriculum. *European Journal of Dental Education: Official Journal of the Association for Dental Education in Europe*, *16*(1), e106–e110.

Molnar, M. (2014, October 7). Student-Privacy Pledge for Ed-Tech Providers Draws Praise, Criticism - Market Brief. Retrieved August 4, 2016, from https://marketbrief.edweek.org/marketplace-k-12/student_privacy_pledge_for_ed-tech_providers_draws_praise_criticism/

Moore, R. K. (2016). Is spoken language all-ornothing? Implications for future speech-based human-machine interaction. *International Work-shop on Spoken Dialogue Systems*. Retrieved from http://www.dcs.shef.ac.uk/~roger/RKM_IWSDS-16.pdf

Mourning, J. (n.d.). 5 Reasons Technology in the Classroom Engages Students. Retrieved April 18, 2016, from http://www.securedgenetworks.com/blog/5-Reasons-Technology-in-the-Classroom-Engages-Students

Mouza, C. (2008). Learning with laptops: Implementation and outcomes in an urban, under-privileged school. *Journal of Research on Technology in Education*. Retrieved from http://www.tandfonline.com/doi/abs/10.1080/15391523.2008.10782516

Munster, G. (2018, February 10). We Ran HomePod Through the Smart Speaker Gauntlet | Loup Ventures. Retrieved March 29, 2018, from http://loupventures.com/we-ran-homepod-through-the-smart-speaker-gauntlet/

Nichols, S. L., & Dawson, H. S. (2012). Assessment as a Context for Student Engagement. In S. L.

Christenson, A. L. Reschly, & C. Wylie (Eds.), *Handbook of Research on Student Engagement* (pp. 457–477). Springer US.

Nield, D. (2017, June 18). Cortana can now replace Google Assistant on your Android phone. Retrieved March 29, 2018, from https://www.techradar.com/news/cortana-can-now-replace-google-assistant-on-your-android-phone

Norman, G. (2010). Likert scales, levels of measurement and the “laws” of statistics. *Advances in Health Sciences Education: Theory and Practice*, *15*(5), 625–632.

November, A. (2013, February 13). Why Schools Must Move Beyond One-to-One Computing | November Learning. Retrieved from http://novemberlearning.com/educational-resources-for-educators/teaching-and-learning-articles/why-schools-must-move-beyond-one-to-one-computing/

O’Boyle, B. (n.d.). What is Siri? Apple’s personal voice assistant explained - Pocket-lint. Retrieved September 5, 2016, from http://www.pocket-lint.com/news/112346-what-is-siri-apple-s-personal-voice-assistant-explained

Office of Public Instruction. (2016, March 29). Superintendent Juneau Increases Impact Of Graduation Matters Montana With 46 New Grants. Retrieved July 23, 2016, from http://www.metnet.mt.gov/OPINews/I036DE86D

Office of Public Instruction. (n.d.). Homepage. Retrieved November 11, 2016, from http://gems.opi.mt.gov/

Ong, T. (2018, February 7). Microsoft’s Cortana app now has native iPad support. Retrieved March 29, 2018, from https://www.theverge.com/2018/2/7/16984792/microsofts-cortana-app-ipad-support

Oswald, E. (2016, July 6). Which virtual assistant would you hire? Cortana vs. Siri vs. Google Now. *Yahoo! Tech*. Retrieved from https://www.yahoo.com/tech/virtual-assistant-hire-cortana-vs-203332605.html

Pallant, J. (2007). SPSS survival manual: A step-by-step guide to data analysis using SPSS version 15. *Nova Iorque: McGraw Hill*.

Pallant, J. (2010). SPSS survival manual: A step by step guide to data analysis using SPSS . Maidenhead. Open University Press/McGraw-Hill.

Patnoudes, E. (n.d.). Engagement from Technology Use Is Different Than Engagement from Learning. Retrieved September 11, 2016, from http://www.edtechmagazine.com/k12/article/2016/07/engagement-technology-use-different-engagement-learning

Pew Research Center. (2014, February 10). Three Technology Revolutions. Retrieved July 9, 2016, from http://www.pewinternet.org/three-technology-revolutions/

Pew Research Center. (2015, April 8). 73% of Teens Have Access to a Smartphone; 15% Have Only a Basic Phone. Retrieved July 9, 2016, from http://www.pewinternet.org/2015/04/09/teens-social-media-technology-2015/pi_2015-04-09_teensandtech_06/

Pierce, D. (2015, September 16). We're on the Brink of a Revolution in Crazy-Smart Digital Assistants. *Wired*. Retrieved from http://www.wired.com/2015/09/voice-interface-ios/

Pinola, M. (2011, November 2). Speech Recognition Through the Decades: How We Ended Up With Siri. Retrieved from http://www.pcworld.com/article/243060/speech_recognition_through_the_decades_how_we_ended_up_with_siri.html

Pope, J. (2014, December 15). Whatever happened to MOOCs? *MIT Technology Review*. Retrieved from https://www.technologyreview.com/s/533406/what-are-moocs-good-for/

Pullen, J. P. (2017, October 24). It's Finally (Sort of) Legal for Kids to Use an Amazon Echo. Retrieved March 29, 2018, from http://fortune.com/2017/10/24/amazon-echo-alexa-children-kids-privacy/

Purcher, J. (2015, May 11). Good Technology Report: Apple's iOS still dominates the Enterprise Market by a Wide Margin with iPad Activations at 81%. *Patently Apple*. Retrieved from http://www.patentlyapple.com/patently-apple/2015/05/good-technology-report-apples-ios-still-dominates-the-enterprise-market-by-a-wide-margin-with-ipad-activations-at-81.html

Ramesh, A., Goldwasser, D., Huang, B., Daume, H., III, & Getoor, L. (2014). Uncovering hidden engagement patterns for predicting learner performance in MOOCs. In *Proceedings of the first ACM conference on Learning @ scale conference - L@S '14* (pp. 157–158). New York, New York, USA: ACM Press.

Rao, L. (2016, June 28). Here Are Some of the New Skills Amazon Just Added to Alexa. Retrieved July 9, 2016, from http://fortune.com/2016/06/28/amazon-alexa-skills/

Ratzel, M. (2012, October 23). Teaching in the Age of Siri. Retrieved March 3, 2016, from http://plpnetwork.com/2012/10/23/teaching-age-siri/

Reisinger, D. (2018, February 22). Apple HomePod Has Already Stolen Some Market Share From Amazon's Echo. Retrieved March 29, 2018, from http://fortune.com/2018/02/22/apple-homepod-amazon-echo-market-share/

Richardson, J. W., McLeod, S., Flora, K., Sauers, N. J., Kannan, S., & Sincar, M. (2013). Large-scale 1: 1 computing initiatives: An open access database. *International Journal of Education and Development Using Information and Communication Technology*, *9*(1), 4–18.

Rohr, M. (n.d.). How school districts are funding 1-to-1. Retrieved January 7, 2017, from https://www.districtadministration.com/article/how-school-districts-are-funding-1-1

Rotgans, J. I., & Schmidt, H. G. (2011). Cognitive engagement in the problem-based learning classroom. *Advances in Health Sciences Education: Theory and Practice*, *16*(4), 465–479.

Russell, V. J., Ainley, M., & Frydenberg, E. (2005). Student motivation and engagement. *School Issues Digest*. Retrieved from https://web.archive.org/web/20060907125059/http://www.dest.gov.au/NR/rdonlyres/89068B42-7520-45AB-A965-F01328C95268/8138/SchoolingIssuesDigestMotivationandEngagement.pdf

Schools, states review cell phone bans. (n.d.). Retrieved from http://www.educationworld.com/a_issues/issues270.shtml

Sculley, J., & Byrne, (1987). *Odyssey: Pepsi to Apple--a journey of adventure, ideas, and the future*. Harper & Row.

Sejnoha, V. (2013, January 11). Beyond Voice Recognition: It's The Age Of Intelligent Systems. Retrieved from http://www.forbes.com/sites/ciocentral/2013/01/11/beyond-voice-recognition-its-the-age-of-intelligent-systems/

Sessoms, D. (n.d.). 5 Reasons Technology in the Classroom Engages Students. Retrieved April 18, 2016, from http://www.securedgenetworks.com/blog/5-Reasons-Technology-in-the-Classroom-Engages-Students

Shapley, K., Sheehan, D., Maloney, C., & Caranikas-Walker, F. (2011). Effects of Technology Immersion on Middle School Students' Learning Opportunities and Achievement. *The Journal of Educational Research*, *104*(5), 299–315.

Sheldon, K. M., & Biddle, B. J. (1998). Standards, accountability, and school reform: Perils and pitfalls. *Teachers College Record*. Retrieved from http://sdtheory.s3.amazonaws.com/wp-content/uploads/2015/01/1998_SheldonBiddle2.pdf

Simonite, T., Simonite, T., Narayanan, A., Werbach, K., Grimmelmann, J., Simonite, T., … Upson, S. (2017, October 5). "Siri, Why Have You Fallen Behind Other Digital Assistants?" *Wired*. Retrieved from https://www.wired.com/story/siri-why-have-you-fallen-behind-other-digital-assistants/

Skinner, E. A., & Belmont, M. J. (1993). Motivation in the classroom: Reciprocal effects of teacher behavior and student engagement across the school year. *Journal of Educational Psychology*, *85*(4), 571.

Skinner, E. A., Kindermann, T. A., & Furrer, C. J. (2009). A Motivational Perspective on Engagement and Disaffection: Conceptualization and Assessment of Children's Behavioral and Emotional Participation in Academic Activities in the Classroom. *Educational and Psychological Measurement*, *69*(3), 493–525.

Snehansu, K. (2013, August 5). Best Technological Ways to Increase Engagement in Classroom. *EdTechReview*. Retrieved from http://edtechreview.in/trends-insights/insights/485-increase-engagement-in-classroom-using-technology

Sprent, P., & Smeeton, N. C. (2007). *Applied Nonparametric Statistical Methods, Fourth Edition*. CRC Press.

Stasko, J. (1998). Personified Agents in the Interface: Exploring the Metaphor. Retrieved July 6, 2016, from http://www.cc.gatech.edu/gvu/ii/person/whitepaper.html

Stipek, D. J. (1996). Motivation and instruction. *Handbook of Educational Psychology*. Retrieved from https://books.google.com/books?hl=en&lr=&id=TjDIqrzfYaMC&oi=fnd&pg=PA85&dq=stipek+1996&ots=AzwLoSLGmI&sig=YG7dbwSnOryjgkkC_0O357133ds

Strayer, D. L., Cooper, J. M., Turrill, J., Coleman, J. R., & Hopman, R. J. (2015). *The Smartphone and the Driver's Cognitive Workload: A Comparison of Apple, Google, and Microsoft's Intelligent Personal Assistants*. The National Academies of Sciences, Engineering, and Medicine. Retrieved from https://trid.trb.org/view.aspx?id=1373185

Sullivan, L. (2016, May 27). Nonparametric Tests. Retrieved October 24, 2016, from http://sphweb.bumc.bu.edu/otlt/MPH-Modules/BS/BS704_Nonparametric/index.html

Tanner, K. D. (2013). Structure matters: twenty-one teaching strategies to promote student engagement and cultivate classroom equity. *CBE Life Sciences Education*, *12*(3), 322–331.

Thompson, B. (1993). The Use of Statistical Significance Tests in Research: Bootstrap and Other Alternatives. *Journal of Experimental Education*, *61*(4), 361–377.

Triola, M. F. (2010). *Elementary statistics* (11th ed.). Boston, MA: Pearson Education.

Tuttle, T. (2015, October 27). The Future of Voice: What's Next After Siri, Alexa and Ok Google. *Recode*. Retrieved from http://www.recode.net/2015/10/27/11620032/the-future-of-voice-whats-next-after-siri-alexa-and-ok-google

Urrea, C. (2010). El Silencio: a rural community of learners and media creators. *New Directions for Youth Development*, *2010*(128), 115–124.

US Department of Education. (n.d.). Use of Technology in Teaching and Learning. Retrieved July 30, 2016, from http://www.ed.gov/oii-news/use-technology-teaching-and-learning

Use Siri on your iPhone, iPad, or iPod touch. (n.d.). Retrieved September 5, 2016, from https://support.apple.com/en-us/HT204389

Use Siri on your Mac. (2017, July 31). Retrieved November 11, 2017, from https://support.apple.com/en-us/HT206993

Voke, H. (2002, February). Motivating Students to Learn. *InfoBrief*. Retrieved from http://www.ascd.org/publications/newsletters/policy-priorities/feb02/num28/Motivating-Students-to-Learn.aspx

Warner, J. (2014, October 1). Without Student Engagement, Nothing Else Matters. Retrieved from https://www.insidehighered.com/blogs/just-visiting/without-student-engagement-nothing-else-matters

Washor, E., & Mojkowski, C. (2014). Student Disengagement: It's Deeper Than You Think. *Phi Delta Kappan*, *95*(8), 8–10.

Waters, R. (2015, February 22). Artificial intelligence: A virtual assistant for life. Retrieved from https://www.ft.com/content/4f2f97ea-b8ec-11e4-b8e6-00144feab7de

Wellborn, J. G. (1991). *Engaged and disaffected action: The conceptualization and measurement of motivation in the academic domain*.

Whitney, L. (2015, May 26). Microsoft's Cortana crosses over to iOS and Android. Retrieved from http://www.cnet.com/news/microsoft-to-expand-cortana-voice-assistant-to-ios-and-android/

Wikipedia contributors. (2016, June 30). Intelligent personal assistant. Retrieved July 19, 2016, from https://en.wikipedia.org/w/index.php?title=Intelligent_personal_assistant&oldid=727669247

Wong, R. (2018, March 14). Now we know why Siri was so dumb for so long. Retrieved March 29, 2018, from https://mashable.com/2018/03/14/why-siri-is-so-dumb/

Zhang, Q. (2014, February). Instructor's Corner #3: Teaching with Enthusiasm: Engaging Students, Sparking Curiosity, and Jumpstarting Motivation. Retrieved July 12, 2016, from https://www.natcom.org/CommCurrentsArticle.aspx?id=4678

Appendix A: EvsD Student Survey

Student Name			
Teacher	Period	School ID#	Research ID#

Research Identification #:

Student Survey

1. I try hard to do well in school.
   a. not at all true; b. not very true; c. sort of true; d. very true
2. In class, I work as hard as I can.
   a. not at all true; b. not very true; c. sort of true; d. very true
3. When I'm in class, I participate in class discussions.
   a. not at all true; b. not very true; c. sort of true; d. very true
4. I pay attention in class.
   a. not at all true; b. not very true; c. sort of true; d. very true
5. When I'm in class, I listen very carefully.
   a. not at all true; b. not very true; c. sort of true; d. very true
6. When I'm in class, I feel good.
   a. not at all true; b. not very true; c. sort of true; d. very true
7. When we work on something in class, I feel interested.
   a. not at all true; b. not very true; c. sort of true; d. very true
8. Class is fun.
   a. not at all true; b. not very true; c. sort of true; d. very true
9. I enjoy learning new things in class.
   a. not at all true; b. not very true; c. sort of true; d. very true
10. When we work on something in class, I get involved.
   a. not at all true; b. not very true; c. sort of true; d. very true
11. When I'm in class, I just act like I'm working.
   a. not at all true; b. not very true; c. sort of true; d. very true
12. I don't try very hard at school.
   a. not at all true; b. not very true; c. sort of true; d. very true
13. In class, I do just enough to get by.
   a. not at all true; b. not very true; c. sort of true; d. very true
14. When I'm in class, I think about other things.
   a. not at all true; b. not very true; c. sort of true; d. very true
15. When I'm in class, my mind wanders.
   a. not at all true; b. not very true; c. sort of true; d. very true

16. When we work on something in class, I feel bored.
    a. not at all true; b. not very true; c. sort of true; d. very true
17. When I'm in class, I feel worried.
    a. not at all true; b. not very true; c. sort of true; d. very true
18. When we work on something in class, I feel discouraged.
    a. not at all true; b. not very true; c. sort of true; d. very true
19. Class is not all that fun for me.
    a. not at all true; b. not very true; c. sort of true; d. very true
20. When I'm in class, I feel bad.
    a. not at all true; b. not very true; c. sort of true; d. very true

And now a few other questions

1. Are you familiar with Siri, the voice command tool, for iPhones, iPod Touches and iPads?
   a. Yes; b. No

If yes, then

2. How often do you use Siri? How many times per week? ____________________________
3. Do you use Siri ever to assist with school work or assignments **at home**? If so, how many times per week? Otherwise, put zero. ______________________________
4. Do you use Siri ever to assist with school work or assignments **in class**? If so, how many times per week? Otherwise, put zero. ______________________________

Proctoring Instructions for Student Survey

Thank you for administering this student survey.

Identifying Eligible Students

For each class period, there will be a list of students that that will take the survey and those that will be excused with the classroom teacher for the administration of an alternative lesson.

For students staying behind to take the survey, please hand out the appropriate survey from the packet for this period to the identified student. If there is a student on the administration list that DOESN'T have a form enclosed, please use one of the enclosed blank forms and have the student place their first and last name on the survey.

Oral Instructions for Students

You will be completing this survey that will provide important information on how you think about your school work, classroom and school. A survey is not a test. On a survey, you are asked for your opinion or point of view. You will not be graded on this survey and there no right or wrong answers. Please read each statement carefully and circle the best answer for each statement.

When you are done, please turn over the survey form to let me know you are finished.

Please answer all of the survey items and only choose one choice for each one.

Please begin!

Completion

When all students are complete, please collect all surveys and place the surveys in the original envelope.

The envelop should be returned to either the individual that provided you the survey envelope OR Dr. Martin Horejsi from the University of Montana.

Thank you!

Appendix B: Treatment Protocol

Initial Teacher Training

The initial teacher training will be conducted by the PI, with a handout described below, that details five categories of Siri's functionality on the iPad. Teachers will be introduced to the tool, then given an opportunity to try sample queries among the different categories and comment and ask questions.

Siri Command Reference

http://hey-siri.io/

Handout Content

Category One: Calculation and Conversion

- Convert feet to yards
- Convert miles to kilometers
- Basic calculations (e.g. "What is 18 plus 41?")
- More complex calculations (e.g. "What is the square root of 9?")
- Basic geometry (e.g. "What is the area of a circle with a radius of 4.5 meters?")

Category Two: iPad Device Control and Commands

- Take a picture
- Increase/decrease brightness
- Turn on airplane mode
- Enable low power mode
- Set a timer
- Set an alarm
- Open an application

Category Three: Simple Data and Content

- Show a map
- Say current date/time
- Weather information
- Word definitions

- Word spelling

Category Four: Web Searches

- Search Google for… specific data (e.g. “Who was the 4th president of the United States?”) or questions (e.g. “How many people can the Earth support?”)
- Search the web for… (will defer to the Bing)

Category Five: Wolfram Alpha Searches (computational knowledge engine)

- Query scientific data (scientific names of animals, atomic weight, food calories)
- Query life database information (planes flying above, time in a specific city)

Teacher Introduction of Siri to Students

After pre-surveys are complete, Siri will be introduced to students in a direct lesson, the format (direct instruction, student discovery, cooperative) left to the teacher. As part of the introduction, the teacher will utilize the framework described above and provide a student-formatted version of the reference examples.

Teacher Direction and Interaction Regarding Siri

Teachers are encouraged to direct students to Siri to answer content questions when appropriate, and engage students in formulating different and better queries during lessons and open learning time.

Teachers are also encouraged to make suggestions before assignment worktimes related to queries and other ways the Siri might be used in content of any particular activity.

Collaboration with Other Teachers

Teachers are also encouraged to share successful practices during the experience, as well as challenges.

Appendix C: Observation Note Taking Form

Teacher Name/Period:	
Date:	
▫ Treatment Group	▫ Control Group

OBSERVATION NOTE TAKING FOR CLASSROOMS

Observation Notes	Coding

OBSERVATION PROTOCOL

Goal: Identify classroom events that show evidence of Siri introduction by classroom teachers.

Coding:

- M: Modeling: Teacher models Siri use during a lesson to an entire class or class subgroup for a personal query or task
- D: Demonstration: Teacher demonstrates Siri use during a lesson introduction to help demonstrate how it might be used in an upcoming lesson or assignment
- R: Redirection: Teacher redirects a student or students to refer to Siri to answer a question or complete a task, instead of asking the teacher or other classroom adult
- C: Correction: Teacher corrects incorrect or ineffective use of Siri by student or students
- P: Praise: Teacher praises use of Siri correct by student or students
- O: Other Siri use by teacher (make notes)