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EXPLORING STUDENT "FLOW" WITH 1:1 TECHNOLOGY

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Abstract

Students live in a technology-rich environment, which aids in shaping their learning and access to information. A teacher's instructional challenge lies in creating a bridge between students' capacity to learn and the resources at their fingertips. The focus of this study was to investigate the impact technology use has within the classroom in relation to its impact on student-monitored self-engagement and teacher-monitored engagement. The exploration of technology's impact on student engagement seeks to provide a better understanding of the shared traits between lessons that effectively integrated 1:1 technology into the classroom. Survey data was collected from student self-reports and two forms of teacher observation. Lessons that result in states of *flow* reflect the highest levels of engagement and 21st century skills, which are promoted by the use of 1:1 technology.

Keywords: Technology, engagement, 21st century skills, 1:1, flow

INTRODUCTION

Teachers are faced with the challenge of creating engaging lessons that teach standardized objectives using technology. These will ultimately prepare students for the advancing digital world in which they learn, work, and engage with others. Throughout the last ten years, educators have confronted a dramatic change in the digital landscape, moving from desktop computers in classrooms and labs, to laptop carts, to 1:1 technology platforms for every student (Heppleston et al., 2011). The latest vision of technology within schools takes form of 1:1 initiatives that provide *all* students with the same device to use throughout their learning experiences in school. While educators are motivated to transition towards 1:1 technology platforms, the question remains: are students more engaged in their learning experience when using technology? Although 1:1 approaches are viewed as advancements, there has been limited research evaluating the relationships among technology use in classrooms, student perception of their cognitive and behavioral engagement, and teacher perception of student engagement.

A Technological Change: Desktop to 1:1

Current students living in an information-saturated and hyper-adaptive digital world have redefined the skill sets needed to be a successful adult (Costa, 2012). To address this changing paradigm in our schools, many schools have opted to put a device in the hands of every student and teacher. A 1:1 technology platform within schools allows students to have immediate access to information through a personal device, thus, changing communication methods as well as altering strategies of collaboration. Immediate access to information puts students in control of their educational experience as they can discover additional support to course content or expand upon their own interests in connection to their learning within the classroom.

This shift to a 1:1 ratio of classroom technology use has accelerated our students into adaptive real-world problem solving, communication, and collaboration skills (Carver, 2016; Barrios, 2004). Teachers are called to create learning experiences that will replicate, introduce and prepare students for real world, digitally rich contexts. Teaching students to be fluent in problem solving and adaptability, as well as digitally literate adults requires lessons that consistently reinforce this skill set throughout their formative school years (Costa, 2012). Allowing students within the same school access to gaining 21st century skill sets include: access to continue digital learning, financial literacy, communication, problem solving, independent and collaborative work skills, demonstrate creativity, innovation, adaptability, responsibility, character and ethical behavior. These skills better prepare students for their future work and overall well-being beyond school (Costa, 2012).

Studies have shown successful implementation focused on unleashing the learning potential of students within a familiar context of technology in preparing schools for teaching 21st century skills (Karlin, Ottenbreit-Leftwich, Ozogul, & Liao, 2018); however, there is nothing in the research that discusses the best practices for using this type of 1:1 technology (Bebell & O'Dwyer, 2010). The infusion of technology in classrooms is a purview of the expansion of technology available to our students that makes learning available and applicable to their lives (Downes & Bishop, 2012). Therefore, educators need to understand the phenomenon of 1:1 computing, and the influence it has on teaching and learning (Bebell & O'Dwyer, 2010; Moustakas, 1994). There is still a need for empirical research to be conducted on the efficacy of cognitive and affective engagement when using a device.

Engagement in Learning

To frame this study we used a definition of student engagement by Dunleavy (2008), who defined it most commonly as the cognitive time-on-task, homework completion, response to challenges in learning, effort directed toward learning, cognition and strategic learning. After completing additional research (Milton & Dunleavy, 2009), this definition of engagement was altered by adding "intellectual engagement" (p. 5). *Intellectual Engagement* is defined as a serious emotional and cognitive investment in learning using higher order thinking skills (i.e., analysis and evaluation) to increase understanding, solve complex problems, or construct new knowledge. Another type of engagement that has been further researched is affective engagement (Hidi & Renningeer, 2006). *Affective Engagement* is conceptualized as student motivation paired with situational or personal interest in a particular concept or topic (Hidi & Renninger, 2006). While we focus on cognitive engagement when addressing classroom learning, we often neglect to focus on the affective ways students are engaged in their learning, which comes from observing their emotional connection their learning experience.

To build upon the framework, the emotional and motivational merge through the work of Shernoff, Csikszentmihalyi, Schneider and Shernoff (2003), defined student engagement as "high involvement in classrooms, which includes concentrated attention, interest and enjoyment, as opposed to apathy and a lack of interest in instruction" (p.3). This definition stems from using Csikszentmihalyi's (1990) "*Flow* Theory" as a student engagement model, which theoretically leads to optimal learning experiences. *Flow* is "the state in which people are so involved in an activity that nothing else seems to matter; the experience itself is so enjoyable that people will do it even at great cost, for the sheer sake of doing it" (Csikszentmihalyi, 1990, p. 4). The *flow* experience is intrinsically rewarding—people seek to replicate those moments or experiences. Students who report high challenge and skill when surveyed on engagement are considered in *flow* during that time period (Csikszentmihalyi, 1990). Similarly, if students report high challenge and low skill then they are functioning in a state of anxiety. Conversely, however, if students report high skill and low challenge they are bored with the lesson. Finally, when students are in experiencing low skill and low challenge they are apathetic in the classroom (Csikszentmihalyi, 1990). Students and teachers must find a niche that helps create these *flow* moments in a classroom (Parsons & Taylor, 2011). While *flow* is a subjective state of complete involvement in a classroom activity, the definition of *flow* provides a conceptualization that represents high emotion and motivation in their work.

Since this research focuses on student engagement, we must deeply analyze pedagogy, purpose of education, future students, and the world we are launching them into. The literature commonly states the need to re-examine our assumptions in learning about students and changing daily classroom practices by infusing practices with engaging pedagogy-based research focused primarily on academic achievement (Parsons & Taylor, 2011; Shapley, Sheehan, Maloney, & Caranikas-Walker, 2010). There is little definitive research on how technology enhances students' "capacity to learn" (Claxton, 2007) or how technology engages them in learning. There is a need for more research coming from the voices of teachers and students, as they are most able to implement and benefit from the research being conducted on engagement. Implementing a culture of learning and genuine student engagement in our classrooms should be a primary goal for all educators (Gilbert 2007; Claxton, 2007; Parsons & Taylor, 2011). Exploring the questions of student engagement raise discussions about the purpose and direction of education.

Engaging Students with Technology

Student engagement has traditionally been a popular topic of research as educators seek to understand and apply specific, research-based strategies that support student learning in the classroom and beyond. Today, creating a classroom experience that is engaging is more prevalent than ever as students have immediate access to information and desire to acquire 21st century skills (Carver, 2016; Taylor & Parsons, 2011). Authentic intellectual engagement requires reciprocity between teachers and students as their relationship becomes a partnership of learning where they work together towards a deep conceptual understanding and contribute their ideas to building new knowledge and devising new practices (Dunleavy & Milton, 2009). Technology is the tool that allows learning to be accessible and relevant. Coupled with an open, caring, and respectful classroom environment, student learning is optimized through self-motivation and deeper psychological engagement in their own education. As students have more control of their learning experience, they become increasingly interested in course content (Taylor & Parsons, 2011). Technology used in a 1:1 environment provides the resources for students to access information, immediately bridging teacher instruction and student learning which promotes student engagement in the course (Barbell & O'Dwyer, 2010). To better understand the degree to which teachers are using technology, the use of Puentedura's contextual framework of Substitution, Augmentation, Modification, Redefinition (SAMR) model to categorize technology is implemented.

SAMR Model

Puentedura's SAMR Model's (2012) four levels describe how learning can be transformed through the integration of technology in a classroom. SAMR consists of four levels of implementation: Redefinition serves as the highest level of integration in a classroom and Substitution is the lowest level according to this model. The SAMR model (**Figure 1**) clearly depicts what types of technology is being used in correlation to effect on student learning. The foundational level of SAMR is *substitution,* which portrays a direct substitution of technology from an earlier technological model, essentially doing the same thing effectively, with or without the presence of the technology, such as the use of a word processer for a lab report. The next level is *augmentation,* which is still a direct substitution of technology; however, improvements occur in functionality that were originally not present. Examples of augmentation are not limited to, but would include, creating a collaborative Google Presentation and sharing with the teacher. The lower two levels (substitution and augmentation) lead to enhancement of instruction, but not total transformation (Strother, 2013). The top two levels (modification and redefinition), however, lead to transformation of teacher instruction in classrooms. The *modification*, which is the first of these higher levels, is when teachers and students alike are able to redesign learning tasks to create an assignment that could not be completed without technology such as, creating a QR code for their project or portfolio of student work. As stated, the highest level of SAMR is *redefinition,* which allows for transformation of learning by creating an assignment that could not be conceivable without technology. This ultimately allows for authentic learning experiences and require formative feedback from students such as the use of a collaborative class blog. The use of the SAMR model for technology is used in classrooms because of its simplicity, which allows teachers and students to clearly understand the differences in implementation levels as well as being the best supported by research (Puentadura, 2012). To best measure student engagement in real time in 1:1 classrooms teachers use *back-channeling* or experience sampling models as evaluation tools (Clesson, 2011).

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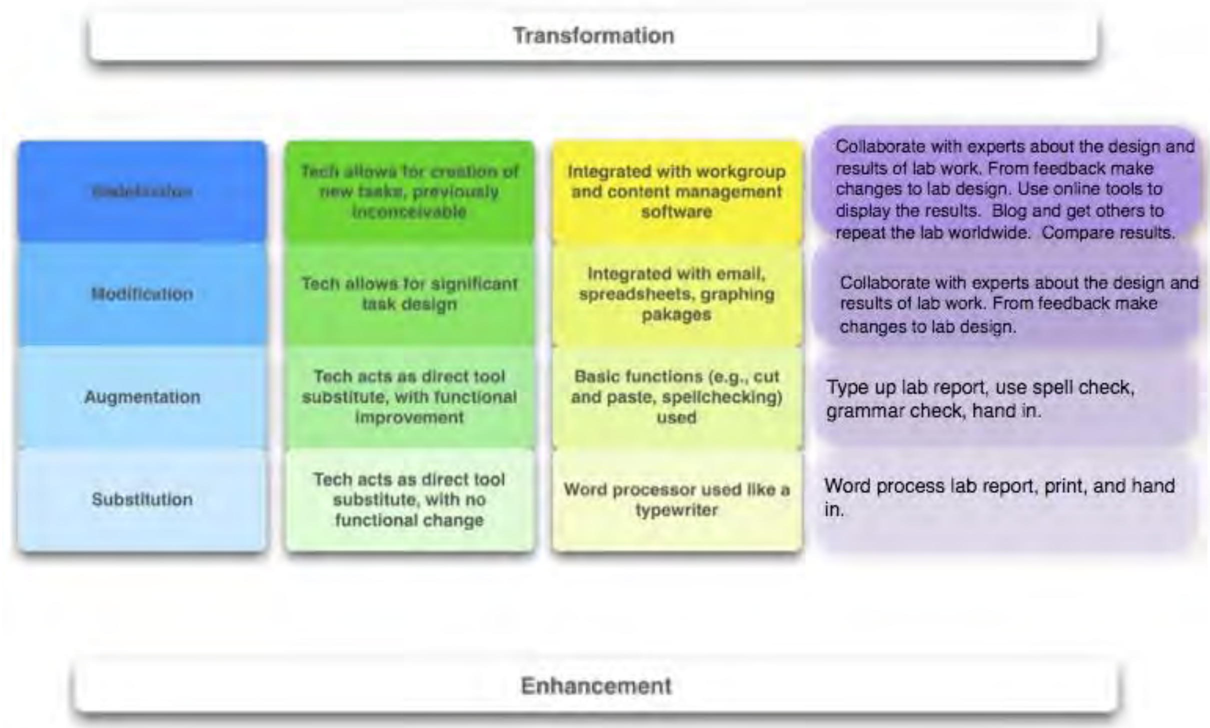

Figure 1. SAMR Model of Technology Classroom Integration

Back-channeling

The use of *back-channeling* emerged as a communication tool to allow students to voice their engagement at a point in time, giving all students an empowering environment to take ownership of their learning through active engagement and participation (Toledo & Peters, 2010). In today's classrooms *back-channeling* is considered to be *student voice*, which we can measure through *experience sampling model,* or ESM, questionnaires buzzed to students. These questionnaires prompt students to determine their level of skill, challenge, enjoyment or expectation of a given learning experience. This allows the student to rate their experience in order to provide the opportunity to self-report their learning experience. The student voice, which is drawn from such ESM questionnaires, provides a unique perspective in educational research on student engagement.

Addressing student engagement means taking the time to understand what high school students find engaging and place student voice as a key factor in determining engagement levels (Prusha, 2012). Awareness of the learners' perspective of their own cognitive engagement can provide a basis for educators to reflect and develop relevant and authentic learning experiences for students within their classrooms (Prusha, 2012). Students' perceptions on their own educational experiences, specifically in conjunction with their increased use of 1:1 technology, present an educational challenge worthy of study. Educators may then have the necessary insight to close the gap between what is perceived to be engaging to high school students and what is actually engaging to students.

Bridging 1:1 Technology and Engagement

Teachers are faced with teaching many digital natives, who may have higher expectations and skills in technology than themselves or their past students. This "net generation" of students learns best through trial and error; this generation of students process information quickly, typically connects with graphics before text, and requires clear relevance to their learning (Downes & Bishopy, 2012). However, as Prensky (2010) argued, "There is a huge paradox for educators: the place where the biggest educational changes have come is not our schools, it is everywhere but our schools. The same young people we see bored and resistant in our schools are often hard at work learning after school" (p.1). It is not surprising that many teachers struggle to engage students of the net generation. Students may not be learning what teachers want them to learn and see little worth in that desired content (Shlechty, 2001). A world where the teacher is the keeper of knowledge is obsolete—we have emerged into an era where teachers have, instead, become facilitators of learning. This requires teachers to shift their roles. Teaching students the skills needed to find, evaluate, analyze and interpret information they find at their fingertips has become a large part of the educator's current role. Those who are willing to take more risks have been found to be more willing to integrate technology with observations of increased student achievement because of improved intrinsic motivation and engagement in the student's own learning process (Howard, 2009). A key to understanding the use of technology in our students' world is listening to their voices while evaluating how technology aids students' awareness of their learning process.

Summary of the Literature

Engagement no longer means solely core knowledge and traditional literacy (i.e., 3R's); instead, students want to learn in more engaging ways while also learning how they learn. Today, students desire to learn in a classroom where the instruction is delivered in socially, emotionally, and intellectually engaging way, where they are drivers of their own educational experience. Technology is part of students' worlds and requires them to have the skills and knowledge to be successful as adults. As a reflection of the increased presence of technology in their daily lives, schools are turning to 1:1 learning environments to give students more ownership of their own learning. As students are learning 21st century skills necessary for the workforce, they are concurrently developing the opportunity to gain awareness of their own learning and acquisition of information. With the increase of awareness comes student understanding of their engagement in their learning experiences. Technology not only provides a platform for understanding student engagement, but also a tool for measuring their cognitive engagement. The challenge still lays in the lack of research and understanding if teacher perceptions of engagement align with student interpretation of their engagement in their learning process (Henrie, Halverson, & Graham, 2015). Through the use of surveying students through the experiential sampling model, student voice can be recorded providing personal observation of their intrinsic motivation or engagement. Teacher observation of student engagement and technology can be monitored through SAMR and IPI surveys. It seems inevitable that technology will play a factor because it has become a standard part of the 21st century classroom. It is our challenge to adapt our current pedagogy to effectively meet the changing face of our classrooms.

Research Questions

The primary goal of an educator is to prepare students for the world in which they will work and live. As a result, it is the teacher's responsibility to create meaningful, authentic learning experiences that will keep students engaged and excited about their own learning. The focus of this research was to investigate the impact of technology use within the curriculum in relation to its impact on student-monitored self-engagement and teacher-monitored engagement. Given that minimal research has been conducted on technology's impact on engagement, the following questions were explored to have a better understanding how to most effectively integrate 1:1 technology into a high school classroom:

1. What are the most effective ways to assess student engagement in 1:1 technology?
    1a. How does student cognitive engagement compare when using teacher observation and student self-reporting methods?
    1b. How does teacher observation of student cognitive engagement relate to the use of technology in the classroom?
2. Is student cognitive engagement higher with the use of 1:1 technology in the classroom?

METHODS

The most effective way for teachers to assess 1:1 technology and engagement is through student self-reports and teacher observations. The focus of this study was to discover any connections between students' self-reports of engagement in their learning process during 1:1 technology use and teacher observation of their engagement. Two types of "engagement observations" were matched to students' use of technology within specified classrooms through the use of the Substitution, Augmentation, Modification and Redefinition (SAMR) scale (Puentedura, 2012).

School Context

The high school involved in this study is located in the northern suburbs of Chicago, Illinois. According the 2010 census data collection, the median family income of the district was $109,135 with an average home price of $565,133 from data collected between 2006-2010 (Illinois Department of Education, 2011). The U.S. Department of Education awarded the community schools with "National Excellence in Education" awards at the elementary, middle school and high school levels. The high school employs nearly 180 faculty members with over 60 different course offerings for students, 24 of those being advanced placement courses. Based on the 2011 Illinois School Report Card, the racial/ethnic background compared to the total enrollment of 2,639 includes: 69.9% White, 17.9% Asian/Pacific Islander, 8.1% Hispanic, 1.4% Black, and .2% Native American.

After receiving institutional review board approval, 46 students were recruited and 45 voluntarily agreed to participate in the study. Participants were enrolled in two sections of *Child Development 161* ranged from ninth to twelfth grade. The course sections chosen were identified at the beginning of the school year for their student size, consistency in curricula pedagogy and diverse populations. The course used in the study was an introductory child development high school elective, which required no prerequisite coursework. Course topics included working with young children, careers in human relations fields, principles of growth and development, brain development, fetal development, pregnancy, parenting and human growth and development from birth to age nine. There was minimal disruption or interruption to the classroom routine except for the few moments when participants were asked to record their answers anonymously to online surveys.

Student participants

The participants in this study were: 17 ninth grade students, 16 tenth grade students, 10 eleventh grade students, and 2 twelfth grade students. Participants identified themselves as follows: 21 White, 13 Asian, 10 Hispanic, and 1 Black student.

Participating colleagues

Four teacher researchers participated in observations of student engagement using the Instructional Practices Inventory (IPI) observation tool. The colleagues ranged in their professional experiences from a second year educator to a veteran educator of 20 years. Two of the four participating colleagues served as instructional coaches within the building for curriculum development. One colleague served on the administrative board within the school and the final colleague was a classroom teacher. All four participating teacher researchers were provided formal training in the IPI walkthrough method (Valentine, 2007). Each participating teacher researcher voluntarily used their planning periods to observe the classroom of study.

Teacher participant

The teacher participant was a seventh grade female teacher who taught Family and Consumer Sciences with a concentration in human growth and development. This was her fifth year teaching at the high school. She was trained in *Instructional Practices Inventory* evaluation (Valentine, 2007), and the *SAMR Model* (Puentedura, 2012). For this research study, the teacher participant was the sole observer for the *SAMR Model*, and recorded data necessary for each observation.

Data Collection Methods & Analysis

Evaluation of student engagement provided an opportunity for both teacher and students to review their level of cognitive involvement in the course curricula at a given moment in time. Data was collected from one external source of observation that used the *Instructional Practices Inventory (IPI)*, which served as the tool for teachers to evaluate student engagement. There was one internal observation tool used to measure self-report of engagement from the students that was gathered using an *Experience Sampling Method* (ESM survey), which would later be coded to score student engagement at a given point in time. Finally, a secondary tool for external observation was used that focused on the use of technology within the classroom; the *SAMR Integration Model* (Puentedura, 2012). These three sources (i.e., IPI, ESM, SAMR) of data allowed for triangulation of data collection to later determine relationships between student engagement and technology within the classroom.

Peer Observation Method: IPI

The Instructional Practices Inventory (IPI) survey was taken by a teacher researcher's observation of the classroom. There was a team of two trained teacher researchers who would validate the level of student engagement during their observation of the class. The data was quantitatively collected through the use of codes provided from the IPI observation tool to measure student engagement within a classroom at a given snapshot of time. Student-engaged instruction, teacher-directed instruction and student disengagement are the three groupings associated with cognitive student engagement according the IPI model. These three groups are then further defined and coded numerically into six categories: student active engaged learning (6), student verbal learning conversations (5), teacher-led instruction (4), student work with teacher engaged (3), student work with teacher not engaged (2), and student disengagement (1). The highest level of coding numbers (5-6) refer the student to student engagement where the lower codes (1-4) are more teacher driven levels of engagement (Valentine, 2007). The codes are then categorized into three levels of engagement: high, moderate, and low by natural intervals. The codes were dated and time stamped in a Google Form to provide reference for later data correlation first in relation to high levels of *flow* extracted from the ESM data then referenced in relation to the level of technology implementation in the classroom during specific lessons of interest (Appendix A).

Student Self-Report: ESM

There are eleven items on the ESM questionnaire that students completed, the questions fit into categories of cognitive engagement, affective engagement and *flow*. Questions on the survey ranged from monitoring student challenge to enjoyment to self-perception of expectations and skills. The students were prompted by the teacher to access the pre-determined series of questions, which originate from engagement surveys adapted from Csikszentmihalyi's (1990) research on science students learning and engagement (Schmidt, Shumow & Durik, 2010). This measured student cognitive engagement through asking a series of questions regarding their status at a given point in observation. The survey was distributed to students through an online Google form. The questions focused on students' cognitive and affective engagement in the work they were participating in at the time, with two items that determined whether students were operating in a state *flow* during a given lesson. The questions evaluated using a Likert scale from 0 ("not at all") to 3 ("Very Much") allowing for no neutral selection to be declared by the student. The responses were then totaled for a given timestamp and divided by the total number of students surveyed to bring up to a class total. The class total was then divided by the total possible scores, which created a score between 0 and 1. We discarded most questions from the survey and focused only on questions number 10 and 11 to collect data in this study. Question 10 would determine student's level of challenge and question 11 would evaluate student's report of skill during the given lesson. Questions such as, "Do you feel positive about yourself during the activity?" and "Did you feel in control of your own learning experience?" are found in the survey given to students. The mean rating acquired from the ESM survey would be plotted onto a grid of challenge and skill to decipher which lessons reported high challenge and skill. The z-scores computed from these plots will discern which lessons students were in a state *flow* during their learning (Hatcher, 2013). In a case where, an observation results in a positive z-score, scores above 0, for both challenge and skill, the observation would identify students functioning in a state of *flow*. Students were prompted to complete the survey at each point in time when the IPI walkthrough took place. This allowed for students to self-report their level of engagement while simultaneously being observed by a trained teacher researcher skilled in evaluating student engagement.

Teacher Technology Observation: SAMR

The SAMR observation was completed by the teacher participant who observed the level of technology use at the determined point in time decided by the IPI observation from the third party. The observation would take place concurrently with that of the two other engagement observations. When the teacher observed classroom activity such as word processing, printing, submitting work it would be coded as *substation*. When typing the creation of written work, use of spell check or development of a presentation was the primary activity it would be coded as *augmentation.* When students are collaborating, researching, designing, gathering information and providing feedback it would be noted as *modification*. Finally, if use of technology in the classroom allowed students to collaboration with a field expert, blog, disseminate, compare and create new material, the teacher would code their technology use at the highest level of the SAMR model at *redefinition.* A diagram outlining the SAMR model of technology can be viewed in **Figure 1**.

When evaluating the data collected SAMR levels will be coded as (1) *substitution,* (2) *augmentation,* (3) *modification* and (4) *redefinition.* These codes are similar to IPI codes in the sense that the codes are used to identify levels of engagement where 1 is consider low engagement, 2-3 moderate engagement and 4 high engagement of technology use. The observations were completed and recorded using a Google form, which provided a timestamp that would later be used to correlate to the other data observations, collected in this study. The level of technology use during each lesson was recorded to determine SAMR scale code that would later be correlated to data with high levels of *flow* and IPI engagement.

Procedures

The research required no formal understanding of the study as students were required simply to provide their observations of their cognitive engagement at given points in time. The participating colleagues were selected for their prior training in the use of the IPI observation tool to measure student engagement from an external observation method. The participating colleagues were selected about one month prior to data collection so that schedules for observation dates could be coordinated amongst the four participants.

The data collection was gathered towards the end of the fall semester during a two-week span, which was divided, into two periods due to holiday break. The data collection began at least ten minutes into the period and concluded before the last ten minutes of class on the random observation dates. There were two data points gathered each class period. The observations for each day would be triggered by the IPI observation from the external source. At the moment of the external observation students would note the task they were participating in at the moment when prompted by the teacher participant. Then after being prompted students would complete and experience sampling model online survey that would gather their response to their cognitive engagement at the moment. Simultaneously, the teacher participant would complete an observation of their technology usage at the same time of the external observation and internal report of engagement. Bias is addressed as the teacher researchers designated all observation times throughout the study to eliminate any alteration in lesson or execution of the lesson. Data was collected a total of 14 times throughout the course of the two-week observation window. The multiple data points provide opportunity to identify trends in the data as the researcher's explored correlations between student engagements both internally and externally recorded in relation to technology use within the classroom.

Data Analysis among Sources

After all data was collected, it was coded numerically according their original scale for the purpose of plotting the data points in time were all coded by letter. The first observation was coded "OB 1" through the last observation coded "OB 14". A number code system was used for two forms of observation: (1) IPI observation of student engagement from third party observers, and (2) SAMR observation of technology use within the classroom. For the ESM, student self-report of engagement, a z-score would be used to evaluate data collected from students. The z-score was determined by taking the mean of the given observation subtracted by the variance of the observation. Then that number was divided by the standard deviation of the focused observation (Cohen & Lea, 2004). The z-scores were established to determine the probability of a score occurring, which created a standard score. Through establishing the two z-scores for challenge and skill we were better able to relate those two independent data sources to each other because we were analyzing distribution of scores (Cohen & Lea, 2004). The two z-scores established for skill and challenge were then used to plot on a t-graph to their state of engagement (i.e. *flow*, apathy, anxiety or boredom).

To address the first research question, we compared the levels of engagement between the IPI teacher observation data and ESM student self-report data. The analysis of the ESM data collected was compiled into a mean rating amongst the sixteen classes observed. The z-scores were then plotted on a grid based upon challenge and skill. The scores plotted would determine if students were in a state of apathy, anxiety, boredom or *flow*. To determine students who were functioning in a state of *flow* in during this study, we took their scores from their ESM self-reported engagement survey. Their responses to the questions "How challenging was this activity?" and "How skilled are you at this activity?" determine their state of *flow*. The positive z-scores, anything above 0.00, for both challenge and skill are considered high levels of *flow* and will be looked in closer detailed compared to the IPI data collected on the same lesson.

If codes were 1-2 for IPI observations and z-scores were both negative, less than 0.00, meaning in an apathetic state of engagement, we determined those observations to be low levels of engagement. If codes were 3-4 for IPI observations and z-scores partial positive and negative for challenge and skill, meaning in state of anxiety or boredom, a moderate level of engagement was noted. Lastly, if the IPI codes were 5-6 or students were in a state of *flow* for ESM observations, it was determined those observations were high levels of engagement. The data was listed as low, moderate or high for each tool in each observation. The observations in which all levels matched, particularly in the high range, were of greatest interest to the study. A deeper look at characteristic traits of lessons were later noted to determine trends in student engagement based upon the reporting.

Through qualitative analysis of the data collected, the researchers charted the sixteen lessons coding their IPI and SAMR in relation to the ESM *flow* or z-scores (Hatcher, 2013). The data collected was categorized into three levels of engagement low, moderate or high. The observations in which all three tools matched were of greatest interest considering all three tools provided the same level of engagement through the observation. The lessons where all three tools matched on low, moderate or high levels were evaluated by characteristics. A qualitative evaluation of the data allowed for the data to be reviewed by finding observations where all tools matched in their view and determine what characteristics of that lesson made the results occur.

Finally, the magnitude of technology integration were matched to the qualitative analysis of engagement reported from internal (ESM) and external (IPI) observation of engagement data. This was completed by noting the level of SAMR on for the lessons that match high in *flow* and high in IPI coding. Lessons with similarities and extreme differences were addressed to identify any trends in engagement and learning experience. For example, if lesson one reports a high z-score from the ESM questionnaire signifying *flow*, a high IPI rating of 5 and a SAMR rating of "R" or 4 then we know that student are highly engaged with the highest form of technological use. From data correlation like this, conclusions were made about the impact technology and its implementation has on student engagement in the classroom. It determined if technology is a factor in twenty first century students reaching a state of *flow* in their learning experience.

RESULTS

The four research questions that guided this study were as follows: (a) What are the most effective ways to assess student engagement in 1:1 technology?, (b) How does student cognitive engagement compare when using teacher observation and student self-reporting methods?, (c) How does teacher observation of student cognitive engagement relate to the use of technology in the classroom? and (d)

Is student cognitive engagement higher with the use of 1:1 technology in the classroom? The data that presented itself from the observations and evaluations were analyzed by each research question.

What are the most effective ways to assess student engagement in 1:1 technology?

Student engagement data was collected using three different tools to assess the efficacy of their observation. The results of three assessment tools were compared to determine if observations corroborated each other's results. After the data was collected from participants, the data sets were coded by observation time and given names such as "OB 1" through the final 14th observation. Initially, the observations were compared to responses from the ESM (**Table 1**). The IPI was then compared to the SAMR Model by levels of low, moderate or high (**Table 2**). Only questions 10 and 11 of the ESM data were used to create a class score for each question on the ESM survey

Table 1. Student level of flow by observation using z-score from challenge and skill survey items

			Student Z-Scores from ESM	
	State	Level	Challenge	Skill
Observation #1	Apathetic	L	-.468	-1.283
Observation #2	Boredom	M	-.270	.348
Observation #3	Apathetic	L	-1.460	-.739
Observation #4	Boredom	M	-2.452	1.978
Observation #5	Anxious	M	.722	-.739
Observation #6	Anxious	M	.127	-.196
Observation #7	Anxious	M	.127	-.196
Observation #8	Flow	H	.921	.891
Observation #9	Boredom	M	-.667	.891
Observation #10	Flow	H	1.516	1.435
Observation #11	Apathetic	L	-.071	-1.827
Observation #12	Anxious	M	.524	-.196
Observation #13	Anxious	M	.524	-.196
Observation #14	Anxious	M	.524	-.196

"Low" levels were always in a state apathy, "Moderate" levels were either in the state of anxiety or boredom, and "High" levels were always in a state of "flow"

The IPI and SAMR survey results had one data point entered for each observation. A "low" score was considered between 1.00-1.99 for SAMR, 1.00-2.00 for IPI and 0-.99 for ESMs. A "moderate" score was considered between 2.00-2.99 for SAMR, 3.00-4.00 for IPI and 1.00-1.99 for ESM. Finally, "high" scores were above 3.00 for SAMR, 5-6 for IPI and 2-2.99 for ESM. The data was then categorized in accordance to the scale listed to determine if there were matches between observation forms (See **Table 2**). Matches were considered if two or three of the three forms of data collection provided the same coded level. This information was used in the comparisons between engagement observations throughout the remainder of the study.

Table 2. Comparison of IPI, SAMR and ESM level by observation

	Observation Level		
	IPI	SAMR	ESM
Observation #1	M	M	L
Observation #2	L	H	M
Observation #3	L	M	L
Observation #4	M	H	M
Observation #5	M	H	M
Observation #6	M	M	M
Observation #7	M	M	M
Observation #8	M	M	H
Observation #9	M	H	M
Observation #10	H	H	H
Observation #11	M	M	L
Observation #12	H	H	M
Observation #13	H	H	M
Observation #14	H	H	M

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IPI: Low =1.00-1.99; Moderate = 2.00-2.99; High = 3.00+
SAMR: Low= 1-2; Moderate = 3-4; High = 5-6
ESM: Low= 0.00-0.99; Moderate = 1.00-1.99; High = 2.00-2.99

When comparing the three tools, there were 14 observations total. Out of the 14 observations, three of the lessons matched using the three evaluation tools. This was seen in OB 6, 7, and 10. OB 6 and 7 reported moderate levels of engagement, and OB 10 reported high levels of engagement. There were 10 observations where two of the evaluation tools matched in their observation of student's engagement (i.e., 1, 3, 4, 5, 8, 9, 11, 12, 13, 14). OB 1, OB 8, and OB 11, the IPI and SAMR reported moderate levels of engagement. In OB 1 and OB 11, the ESM reported low levels of engagement, where in OB 8 the ESM reported high levels of engagement. OB 4, OB 5, and OB 9 the IPI and ESM reported moderate levels of engagement and the SAMR reported high levels of engagement. In OB 12, OB 13, and OB 14, the IPI and SAMR reported high levels of engagement, and the ESM reported moderate levels of engagement. In OB 3, the IPI and ESM reported low levels of engagement, and the SAMR reported moderate levels. OB 2 was the only observation where all three tools mismatched in their record of engagement levels in students. The IPI reported a low level, the SAMR reported a high level, and the ESM reported a moderate level.

How does student cognitive engagement compare when using teacher observation and student self-reporting methods?

From the data collected, there were 7 occasions when both ESM and IPI resulted in the same level of engagement (low, moderate, or high). OB 3 was reported as low levels of engagement. OB 4, OB 5, OB 6, OB 7, and OB 9 reported moderate levels of engagement. OB 10 reported high levels of engagement.

Low engagement observation

During the IPI observation and student ESM reports of low engagement, students were participating in note taking with the support of a PowerPoint presentation, which was provided for personal navigation on the course Google Site. Students reported to be in an apathetic state during this lesson (i.e., low challenge and low skill), which was also noticed by the teacher evaluator and from the students themselves.

Moderate engagement observation

The five remaining matched observations were all considered moderate levels of engagement. During these lessons, students were using their Chromebooks for their coursework. Common characteristics of these lessons included work that students were doing to research information for worksheets that were on topics currently being discussed in class, or working on their portfolio project which included organization of research, annotation and word processing. All moderately engaged lessons included previously introduced material, which is unique in comparison to the low or high engagement observations.

High engagement observation.

The highest engagement lesson was during OB 10. Students reported to be highly engaged in their researching and use of online portfolio development through new applications such as Pinterest, which was dually noted by the teacher evaluator during their observation of student engagement. During this lesson, students were introduced to new material and a new final project that would be their work for the next week in class.

There were seven comparisons that resulted in no matches between IPI and the ESM students were using technology to complete their project work, take notes or complete continued research. In six of the seven observations where IPI and ESM levels of engagement did not match, the teachers observed higher levels of engagement than the students. Therefore, IPI to ESM comparison proved to be 50% effective in matching engagement teacher observations to student self-reports of engagement in this study because 7 of the 14 observations recorded the same level of observation or matching of engagement based upon the low, moderate and high level scale. These two forms of engagement observation, teacher observation and student self-report, matched in 50% of the observations conducted.

How does teacher observation (i.e., teacher evaluator and teacher researcher) of student cognitive engagement relate to the use of technology in the classroom?

In this study, nine of the 14 observations using the IPI and SAMR were recorded at the same level (moderate or high). These two forms of teacher evaluation of student evaluation matched in 64% of the observations conducted. Of the observations using the IPI and SAMR, zero were recorded as low, five were recorded as moderate (e.g., OB 1, 6, 7, 8, 11), and four were recorded as high (e.g., OB 10, 12, 13, 14).

Similar to the matches between IPI and ESMs, seven of the 14 observations using these tools were recorded similarly; one was recorded as low (e.g., OB 3), five were recorded as moderate (e.g., OB 4, 5, 6, 7, 9), and one was recorded as high levels of engagement (e.g., OB 10, see Table 3). These two forms of teacher evaluation of engagement and student's evaluation of their engagement matched in 50% of the observations conducted.

In the observations where moderate to high peer-teacher observations and technology observations were reported, students were participating in activities such as note taking (OB 1, 7, and 8), research (OB 6, 10, 12, 13, 14), and discussion with the support of technology (OB 11). In the two lessons that reported high engagement and technology use, students were using their Chromebooks to conduct research and create their final portfolio.

How does the IPI, ESM, and SAMR relate when evaluating student cognitive engagement to the use of technology in the classroom?

The two observation tools that matched the least in this research were ESM (student self-report) and SAMR (technology teacher researcher observation). There were only three instances of the 14 observations that matched with two being at a moderate level (e.g., OB 6, 7) and one being at the high level (e.g., OB 10). There were only 21% of the observations matched between these two tools engagement observation tools. In fact, these three observations were also matched with the IPI, so there were no instances to report where just the ESM and the SAMR observations matched.

Moderate engagement observation

In the two matched observations at the moderate level (OB 6, 7), students were conducting research and taking notes on course content based upon information introduced in earlier in class. Moderate observations would include technology use in an augmentation to the normal course curriculum.

High engagement observation

There was one observation that extracted a high engagement level observation across all three measuring systems, which suggests that students were using technology in a modification or redefinition implementation. This means that students were unable to complete their coursework without the use of technology in that lesson.

Finally, the IPI tool managed to be the most reliable form of observation as it matched most frequently with the SAMR and ESM, 13 of the 14 observations. The SAMR matched either the IPI or the ESM in 9 out of 14 observations, and the ESM matched either the IPI or the SAMR in seven out of 14 observations. The IPI had 93% accuracy among the tools, the SAMR had 64% accuracy among the tools, and the ESM had 50% accuracy among the tools.

Is student cognitive engagement higher with the use of 1:1 technology in the classroom?

To determine if students are in a state of *flow* a comparison of the challenge and skill ratings was used to determine their learning experience. The scores from the challenge level ranged from -2.452 to 1.516 and from -1.827 to 1.978 for skill across the 14 different observations. The average challenge rating across all observations was 1.44 and the average rating for skill was 2.44, suggesting that students generally reported higher levels of skill than challenge (See **Table 1**). To take a closer look at each observation, the ratings were converted to z-scores to compare each of the 14 observations to each other. The observations of most interest were those with the highest positive z-scores for both challenge and skill because those lessons would identify students who were reporting the highest likelihood of being in a state of *flow*. A high z-score for *flow* was considered when both scores where positive in challenge and skill. There were only two observations that suggested students were in *flow* (i.e., OB 8, OB 10). In both lessons, students were introduced to new content, given opportunity to extend their concept understanding through research and then create a product from the increased understanding. These two lessons relied on the use of technology as a tool to create their final product as well a tool to redefine or modify their learning experience. OB 8 had a z-score of .921 for challenge and .891 for skill and OB 10 had average z-scores of 1.516 for challenge and 1.435 for skill.

Students reporting anxiety, boredom and apathy

Observations that were classified as moderate were considered to have either challenge or skill z-scores between less than 0.00 or a negative value. In OB 5, 6, 7, 12, 13, and 14, students reported positive challenge and negative skill this is where students would be classified anxious in the lesson. Characteristics of lessons where students were anxious included observation and research on a sensitive topic such as Sudden Infant Death Syndrome, taking notes and observing a simulator. In OB 2, 4, and 9 where students reported negative challenge and positive skill scores, students would be classified as bored throughout the lesson. Characteristics of lessons were students reported boredom included research and creation of an online resource account. Similarities in the content of these lessons for specific scores reference can be found in **Table 1**. There were three sets of ESMs in which the mean student ratings were negative z-scores for both skill and challenge were OB 1 (skill = -0.70, challenge = -1.28), OB 3 (skill -1.460, challenge -0.739) and OB 11 (skill -0.071, challenge -1.826). In observations that students reported averages indicating negative skill and challenge z-scores, the students are suggesting to be in a state of apathy with the activity, thus reporting little engagement in their learning experience. Characteristics of the lessons when student reported being bored included note taking with presentation support both through a presentation and individual access to presentation.

DISCUSSION and CONCLUSIONS

The purpose of this research study was to methodically explore student engagement with the use of 1:1 technology, as technology is a prominent feature of the 21st century classroom. Throughout the study, student engagement was evaluated through using a framework of three different observation tools (i.e., IPI peer teacher observation, SAMR technology use through teacher observation and ESM engagement student-survey). This data was then divided by natural intervals into low, moderate and high levels of engagement. The levels of engagement allow for critical qualitative evaluation of how the tools measured student engagement in the classroom.

IPI Best Student Engagement Observation Tool

The most rated student engagement observation tool proved to be the IPI peer teacher evaluation. When looking critically at the engagement levels of students, the IPI survey engagement levels most frequently matched those of the students. This shows that the classroom teacher has a better gauge of their students' engagement with the use of technology than either the isolated SAMR survey or ESM survey. The SAMR survey did identify the context, or environment, of the lesson within the classroom but it did not work in evaluating students' ability to reach a state of *flow* within a lesson. The observations of technology did not address the cognitive and affective engagement of interest in this study, which could be a result of the design of the chosen tool. The data collected from students through the ESM surveys to solely determine students' engagement state are self-reported, which may be a limitation because of errors in student self-reporting due to memory, completion attitude, exaggeration or deliberate falsification (Shernoff et al. 2003; Prusha, 2012). Furthermore, the ESM survey shows mostly that students were not reaching a state of *flow* within the lessons. Students more often showed states of boredom or anxiety within the lesson, which connects to the 2003 research conducted by Shernoff and Csikszentmihalyi because their work was somewhat active, structured and intellectually challenging for at least part of the time (i.e. note taking, individual work, research and project production). However, it was not active to the point that would sustain a state of *flow* (Shernoff et al. 2003, p. 171). While the students are honest in their evaluation of their state of engagement within a course, a holistic perspective from teacher observations shows the impact or role that technology can play in student engagement within a classroom.

Student engagement is higher with 1:1 technology

The lessons that exhibited the highest levels of engagement across all of the observation tools, had specific characteristics of the lessons. Throughout the two lessons of *flow*, students were working independent of direct teacher instructions; however, they were working collaboratively in small groups. The students were given the option to use their 1:1 device as a method or tool for research, analysis and communication of their found information. A majority of the class opted to use their device to research as it was noted through the IPI observation. These lessons with the use of technology allowed for students to practice and enhance their 21st century skills that are the foundation of high engagement in 1:1 environments (Wagner, 2008).

Characteristics of an optimal *flow* lesson

There was one lesson of particular interest in the study that showed high levels of engagement across all three of the observation tools. The lesson observed during OB 10 was unique because new information was presented to students, then they were released to conduct independent work with teacher facilitation. Students were cognitively challenged with the task of researching various components of their portfolio projects. Likewise, the positive emotions extracted from students because of their autonomous work and skill competency provided an affective learning experience during this lesson, which reflected in the high levels of engagements. In this lesson, students were in control of their learning pace, direction and reliance on support of their teachers and peers. When students feel a sense of autonomy and decision in the direction of their learning experience, they are more driven to self-motivate their depth and quality of their work in that particular activity (Taylor & Parsons, 2011). This lesson did just this as students were given the new challenge to explore vast resources through the portal of technology with their Chromebook, and as a result they own their learning experience that particular lesson. Learning opportunities such as this lesson are intrinsically rewarding to students, and by human nature, we strive to replicate experiences such as these. As students strive to master their understanding of the work they are collecting for their portfolio, students seek new challenges and develop greater levels of understanding and skill (Nakamura & Csikszentmihalyi, 2002).

In summary, the results of this study suggest that the IPI engagement observation tool is the most successful in determining consistent levels of student engagement with the most reliable results. The IPI provides opportunity for technology to be incorporated into the coding of the classroom engagement levels. Ideally, teachers are tasked to develop lessons with challenging, relevant and technology infused activities that allow students to feel in control of their learning environment and confidence in their ability that is holistically their learning experience (Taylor & Parsons, 2011). In lessons that note high levels of engagement, students concentrate, experience enjoyment, are provided with feedback and build continued interest in continuing the work begun in that lesson (Shernoff et al, 2003). When creating lessons for the future, teachers must strive to provide such engagement by balancing challenge and skill, but also know their learners to adapt lessons to ensure all students have the opportunity to experience learning in a state of *flow* in our technology infused 21st century classroom.

Limitations

Readers should bear in mind that there are limitations of this study. First, being the logistical limitation of the student population used to survey throughout the study as students were from two different classes of the same course. Similarly, the second limitation was also logistical as the winter break for the district fell in the middle of the data collection period, which may have minimally affected the results provided by students. Third, this study relied on student self-reported data that forced students to subjectively evaluate their learning experiences. Student self-reported data is vulnerable to inaccuracies due to students potentially failing to remember their experiences, purposely misrepresent, exaggerate or have hasty completion of the survey (Henrie, Halverson, Graham, 2015).

For this study, it was important to use multiple observation tools to seek data from teachers and students alike. The triangulation of the three observation tools: (a) IPI peer teacher observation, (b) ESM student self-report and (c) SAMR technology observation provided opportunities for reliability in the observations conducted.

Implications

After conducting this study, there is more of an understanding surrounding the challenge of engaging students in learning at high levels within the classroom. Now more than ever, the importance of promoting independent learning that teaches students how to critically analyze, process and produce, as well as learn how to learn, is not only what is suggested for teachers to implement (Bebell & O'Dwyer, 2010; Bowen, 2005), but it is also what students are craving if they are to be at high levels of engagement or reach a state of *flow* within the classroom. Creating those environments in a 21st century classroom includes the infusion of technology in a nature that is seamless to the work created that balances challenge and their skill (Carver, 2016; Downes & Bishop, 2012). Technology appears to have a positive impact on student's level of engagement as noted in the lesson of this study where students were motivated to autonomously learn, collaborate with peers and produce their own work (Blazer, 2008).

There is a need for continued research to expand on the understandings found in this study. It would be most desirable to find more lessons similar of the 10th observation to better understand the current characteristics of *flow* lessons and discover additional characteristics that promote students to be in a state of positive challenge and skill. For example, would students feel engaged when assigned highly effective and relevant tasks of their choice if they are too easy or too challenging? There is a need for continued exploration of the relationship between teacher crafting of such lessons and the role of the teacher as a facilitator of learning that promotes *flow*. It is only then that we will have a more holistic view an understanding of how we can promote highly engaged learning with the infusion of 1:1 technology in our classrooms.

Conclusions

Teachers should continue to focus on the development of lessons to reflect the characteristics of the lessons that support *flow* in this study (Csikszentmihalyi, Schneider & Shernoff, 2003). Practices such as (a) creating interactive materials, (b) providing opportunities for collaborative learning, and (c) giving students feedback which was evident from the characteristics of the lessons that reported high levels of engagement. The reciprocal relationships of these four components provide students with high levels of engagement because their challenge and skill are appropriate to each student's learning abilities. It is in the development of lessons which extract states of *flow* we are optimizing student engagement in the course material. In the lessons that extracted the highest levels of engagement, 21st century skills such as collaboration, critical thinking and analyzing information (Bebell & O'Dwyer, 2010) were all being promoted by the use of 1:1 technology. By appropriately integrating technology into classrooms to promote collaboration and interactive experiences we have potential to increase student achievement because of improved intrinsic motivation and engagement in the student's own learning process that occurs through student reaching a state of *flow* in such lessons (Howard, 2009).

Moving forward, the key component of this study is that teachers must develop learners who are focused, committed, and self-regulated in order for them to lead us to creating a learning culture and environment that promotes high levels of engagement (Martin & Downson, 2009). By appropriately and continuously challenging students to optimally perform tasks, paired with student self-motivation due to their empowerment of control of their learning pace, a state of *flow* is established which ultimately leads to increased students achievement (Csikszentmihalyi, Schneider & Shernoff, 2003).

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