THE IMPACT ON ACHIEVEMENT FROM STUDENT AND PARENT ATTITUDES

TOWARDS USING SMARTPHONES IN SCHOOL

Joshua Todd Gordesky, B.A., M.S.

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APPROVED:

Cathleen Norris,Major Professor and
    Interim Chair of the Department of
    Learning Technologies
Bill Elieson, Committee Member
Gerald Knezek, Committee Member
Kinshuk, Dean of the College of
    Information
Victor Prybutok, Vice Provost of the
    Toulouse Graduate School

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The purpose of this research was to determine what type of correlations existed between student and parent attitudes towards using smartphones in school and the resulting impact on achievement, specifically for low-achieving students. Participants in the study were third-grade students and their parents from a primary school in Singapore. The study employed a quantitative analysis to understand the correlations among the different participant groups. The instruments used were Likert-based surveys, along with scores from mid-year and end-of-year achievement exams in English and science. The three most relevant major findings showed that (a) low-achieving students show a positive attitude toward completing science activities, which correlates with an increase in science achievement; (b) the parents of low-achieving students appear to provide their children with autonomy in using their smartphones, which correlates with an increase in science achievement; and (c) having a smartphone and using the smartphone to complete school work is important to low-achieving students and their parents.

ACKNOWLEDGEMENTS

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CHAPTER 1

INTRODUCTION

Mobile learning offers many new and exciting opportunities to engage students in deep learning experiences. While all students should have access to these mobile learning opportunities, it is the low-achieving students who offer the most promise for researchers. That promise comes in the form of mobile instructional design strategies that are implemented to improve their academic performances and their self-confidence in the learning process. With low-achieving students having the most to gain through improvement in their standardized exams and everyday work in class, this group of students and their parents deserve careful attention and dedicated research projects. The low-achieving students must become a high priority to instructional designers, teachers, school administrators, and parents so that all students—not just the ones who have medium or high achievement—are afforded the same opportunities to advance in their chosen professional fields.

Therefore, the purpose of this study was to gain insight into how the use of smartphones could improve the academic performances of low achieving students. That understanding was achieved through a careful analysis of the attitudes and academic performances of high- and low-achieving students and their parents in two subjects— science and English—using smartphones as the primary learning tools. This study directly builds on findings from research showing that grade school students show positive feelings towards learning with smartphones (Khaddage, Norris, Soloway, & Knezek, 2014). This study's analysis can be used as one piece of a larger puzzle made of other related studies meant to determine future directions for mobile learning

instructional design concepts to promote 21st century critical thinking skills. In regard to this study, the examination the relationships of third-grade students, their parents, and changes in achievement scores from the middle of the school year to the end of the year offered interesting findings that should be used to develop more effective learning strategies, especially for low-achieving students.

The setting of the data collection is in Singapore, a country well known for using progressive learning strategies in its educational system from K-12 through higher education institutions. The concept of mobile learning is key to the Singaporean government's educational initiatives for students of all ages and academic achievement groups. Students are placed in achievement groups based on their achievement scores at the end of second grade. These achievement groups are delineated clearly in Singapore into:

- High-Achievers (HA)

- Medium-Achievers (MA)

- Low-Achievers (LA)

Three research questions were created to analyze relationships from the perspectives of the students and their parents. These research questions are:

1. Is there a relationship between a student's positive beliefs about using smartphones for learning and an increase in achievement scores?

2. Is there a relationship between a parent's positive beliefs about his or her student's use of a smartphone for learning and an increase in achievement scores?

3. Is there a relationship between students' and parents' positive beliefs about using smartphones for learning?

Specifically, those relationships were investigated with the focus on the LA student and parent perceptions. The reason for taking this approach is that HA students are presumably already using effective learning strategies, with or without the use of mobile technology. While the MA students have some room to improve their academic performance, they tend to receive a great deal of attention because they are almost at the top of the academic hierarchy. The LA students need the most attention because this group tends to face the most challenges in terms of socioeconomic standards of living and parental support.

In addition, the investigation of the relationships in this study should be viewed within the context of the major change currently happening within the Singaporean educational system. This change involves moving away from a teacher-centered learning environment in which students are passive recipients of knowledge to an active, inquiry-based setting where students generate questions, ideas, and demonstrate other forms of 21st century critical thinking skills.

When smartphones are used as the foundation for the lesson, students and teachers will feel a new sense of freedom that allows them to engage in meaningful learning experiences. According to Norris and Soloway (2011), with mobile devices, students and teachers will find themselves in learning environments modeled on *We Learn* instead of *I Teach* (p. 7). A new sense of independence, confidence, and competence among students is to be expected by transitioning from a curriculum model

in which the teacher gives knowledge to students to a model in which the students find the knowledge for themselves with the teacher's guidance and smartphones.

For the purposes of this study, comparing the positive perceptions of students and parents about the use of smartphones is being correlated with changes in achievement scores. There are several unique features of this study that are unique. First, most studies that examine mobile learning projects with K-6 students analyze results that occur in a matter of a few weeks. This study looks at the changes from an achievement standpoint that happened from the middle of the school year to the end of the school year. Another way that this research project is different from many others is that student and parent perceptions are brought together in the same study. For instance, each student's survey responses were matched with those of one of his or her parents. Usually, these kinds of investigations gather data from a group of students or a group of parents, but rarely are the students and parents matched in the same research project.

In addition, two sets of academic achievement scores were compared on the basis of the change in those scores from midyear to the end of the year. The change in these scores is critical to determine whether the students are learning with the help of mobile devices. An increase in the change in scores shows that learning occurs with smartphones, while a decrease shows that either no learning occurred or that some kind of confusion happened due to the smartphones that could be hindering learning.

The two academic subjects used in this study are English and science. These subjects were chosen because they represent two foundational skills that the students will need to master in order to develop 21st century critical thinking skills. Also, these

subjects represent two different ways of thinking about the content. For example, in English, many answers to lessons are subjective while in science the answers tend to be objective.

The subjective nature of the answers in English class are a good fit for a mobile learning environment because students can share their responses with each other and their parents through emails, texting, and posting ideas to message boards or wikis. Then, the feedback that readers will provide the students could happen in an asynchronous manner, in which case the students could reflect on the comments and consider changing how an idea was expressed, correct spelling errors, or adjust sentence structure.

The objective nature of science classes also provides an ideal setting for using smartphones in the classroom. Students can take pictures of objects, label those pictures, make voice recordings of observations, and draw diagrams of their views of abstract concepts. Using smartphones in this way enables students to visualize their thought processes over a number of subjects that would not be possible or at least not as easy to produce without the use of a mobile device. Similar to the sharing of ideas that would occur in English classes, the students could collaborate on projects and submit their ideas to each other, to their teachers, and to their parents for feedback. The immediacy of this feedback will be a critical part of the learning process so that the students can consider the comments and make any necessary adjustments based on those new ideas.

Achievement scores are being used in this project as an accepted measurement of whether learning has occurred. Of course, some researchers argue that achievement

exams are not true reflections of learning because some students freeze at the idea of taking a standardized test, while other students excel in that area of education. In addition, another argument against using standardized achievement exams to measure learning is that while some teachers might direct their instruction toward students doing well on the exams, other teachers might focus on teaching the concepts of the subjects. The assumption with the latter group is that students will do well on achievement tests if they master the fundamentals of the subjects. However, a student's performance on achievement exams includes more than just input from the teachers: two other important factors are perceptions about learning tools and the impact of outside influencers. In the case of this research project, the learning tool is the smartphone and the outside influencers are the parents.

Student perceptions of smartphones is a critical factor in recognizing the manner in which students engage with the content and whether they learn the material at a shallow or a deep level. In essence, the popular saying "Perception equals reality." is being studied in this project. One assumption going into this investigation is that students will develop either a positive or a negative view of using smartphones for learning. A positive view might occur if the student sees a cause and effect relationship between using the phone as an integral part of the study process and receiving high grades in class and on achievement exams. Conversely, a negative view could occur if the student does not believe that the smartphone is a helpful tool and either does not use it in the prescribed manner during class or avoids using it at all. Consequently, the likely outcome would be that the student would receive low grades in class and on achievement tests. Then, there might be a downward spiral effect that could do even

more damage to the student's sense of competence and confidence. Therefore, this study aims to begin the process of finding those relationships that would prevent that downward spiral and actively promote a sense of confidence and competence in achievement.

The other critical factor being measured in this study is the impact of the parents' attitudes about using smartphones for learning on the students' achievement. It is assumed that achievement scores increase with parents who are involved in their children's education by promoting a sense of well-being in the students and offering a path toward making learning fun and successful. On the other hand, it is also assumed that achievement scores decrease with parents who do not take an interest in their children's education and end up doing more harm than good. In this case, the child ends up looking to the parent for guidance and support that never appears. Also, there is an emotional aspect of the learning process that parents supply, which is helpful for the students to feel good about themselves and their progress in obtaining new levels of achievement. Even the lack of perceived parental involvement could derail the progress that a student might be making in class. Accordingly, this study seeks to understand the parents' perspective about their roles in educating their children in a mobile learning environment.

CHAPTER 2

REVIEW OF RELATED LITERATURE AND THEORY

Organization of this Literature Review

The eight subjects covered in this literature review provide the appropriate

context around the heart of this study. For instance, the results of this study should be

viewed in the context of Singapore's move from a traditional, teacher-centered

educational system to one in which the students are in control of the learning process.

This learning process takes place in a new learning environment, which is the second

subject, and is based on teaching 21st century critical thinking skills. These critical

thinking skills require students to ask questions and reflect on information as they relate

to the subjects on their own as opposed to being given the information, which happened

in the previous, traditional educational system. The primary tool for promoting critical

thinking is the third subject, the mobile devices. These devices come in the form of

smartphones and enable students to share information via text, websites, blogs, and

other social media and software tools.

Students take information presented to them by their teachers and reflect on it

through an inquiry-based learning system, which is the fourth subject. The inquiry-based

learning system is a learning theory that motivates students to ask questions about the

subjects and the opinions of parents, teachers, and other students in an effort to

become deeply involved in the learning process. That deep learning process happens

because the students use their smartphones to investigate questions and subjects both

at school, at home, and in other places that they visit such as on field trips or walks

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through a park. This seamless way of blending educational settings is known as seamless learning, which is the fifth subject of the literature review.

The goal behind placing students in a seamless learning environment is that they will become motivated to apply the inquiry-based learning concepts wherever they are and with whomever they are speaking at any moment. This motivation is the primary driver of teaching students how to become self-directed learners, the sixth literature review topic. In addition, the smartphones promote self-directed learning by providing countless opportunities to communicate with others and to create artifacts that demonstrate an understanding of any subject.

One of the main contacts outside of the classroom to continue the motivation for seamless learning in a self-directed manner using an inquiry-based knowledge-building model is the parents—the seventh subject of the literature review. The parents play a critical role in reinforcing the new habits being promoted by the Singapore government's central goal of producing students who embrace the concepts of 21st century critical thinking skills in order to become well equipped to handle the competition and challenges of a technology-based world.

Finally, all of these concepts such as 21st century critical thinking skills, mobile learning, inquiry-based learning, seamless learning, self-directed learning, and parental involvement can be judged for success objectively through formal assessments of student knowledge, which is the last subject of the literature review. These assessments come in the form of standardized exams. As part of the movement toward a student-centered classroom and the improvement of critical thinking skills, teachers can no longer teach with a focus only on having the students do well on these achievement

exams. Instead, teachers are now focusing on developing students who engage in deep learning and connect the new information with what they already know. In that process, there should be a demonstration of that knowledge on achievement exams. The eight topics that will be discussed in the following order are:

1. The Educational System in Singapore,

2. 21st Century Critical Thinking Skills,

3. Mobile Learning,

4. Inquiry-Based Learning,

5. Seamless Learning,

6. Self-Directed Learning,

7. Parental Involvement, and

    Achievement Scores.

Singapore's Educational System

Current System

Appreciating the perspective of the Singaporean educational system is a critical factor in interpreting the data from this study. For instance, the Singaporean government made clear its intention to educate its students by using mobile devices through an investment of $2 billion in 2005 (Weber, Yow, & Soong, 2005). However, the origin of mobile learning in Singapore goes back to the 1999 eduPAD project—a collaborative project among schools, the business sector, and the Ministry of Education that used the eduPAD—which was a small mobile device with an 18cm screen and 16MB of storage space (So, Kim, & Looi, 2008).

Historical Approach

To appreciate the historical roots of teaching methods in Singapore, it is necessary to first examine the way in which curricular innovations were established. For instance, the late 1950s featured a dramatic shift away from British geography and history and toward Malayan subjects and themes in textbooks (Tan, 1997). The change in emphasis on school subjects, as noted by Tan (1997), mirrors contemporary political developments as the country moved toward independence from British rule. One example of a renewed curricular emphasis comes with social studies and the importance placed on individual thinking in students, which also impacts how the government and its people view citizenship and each person's role in contributing to the growth of the country (Sim & Print, 2005). The move toward teaching students how to think for themselves is a departure from the traditional way of teaching in Singapore.

In the country's early days as an independent nation, Singapore was experiencing problems in its school system. For instance, in the early 1970s, only 444 out of every 1,000 students reached the fourth grade after 10 years (Organisation for Economic Co-operation and Development ([OECD], 2010). Then, as the education system began to improve, teachers and parents came to expect a lot from their students. One 3-year study on self-efficacy of students in a Singapore school found that a group of high-achieving 13-year-old students felt a great amount of stress in terms of their academic self-concept because of the high expectations set by teachers and parents (Liu, Wang, & Parkins, 2005). As a part of this historical background, the role of the teacher was to provide students with the answers, which they learned through rote drill and practice.

Twenty-First Century Critical Thinking Skills

Definition

Because this study investigates the relationships between students' and parents'

positive perceptions towards mobile devices on the one hand and academic

achievement on the other hand, one of the expected outcomes is that educators can

better understand how to develop mobile learning teaching strategies that promote the

critical thinking skills that students will need to succeed and compete in the 21st

century. Dede (2010) highlighted the difference between critical thinking skills of this

century and the previous one, noting that the tremendous growth of complex

communications and information technology has been the key differentiating factor

between the skills of the two centuries. Ananiadou and Claro (2009) identified the three

categories of skills and competencies within critical thinking, problem solving, and

collaboration that students will need to use in the 21st century:

- Information

- Communication and ethics

- Social impact

In addition, this study provides another way of defining these skills by focusing on

the technical aspect of knowledge, which involves gaining a firm understanding of

information science skills, fluency in digital media, and advanced computer and Internet

communication skills (Silva, 2009). Overall, the push to clearly define 21st century skills

comes in large part from the growth of firms in the fields of communication, information

technology, and electronic publishing, as well as the growth of knowledge industries

around the world that demand an English-speaking workforce that can combine

complex research (Altbach & Knight, 2007).

Students with one or more of those abilities will survive and thrive in an

international economy that is quickly becoming more interconnected, which allows any

country to be competitive. For example, in terms of background for this study, the

Singaporean government has the success of students with 21st century skills as a top

priority to continue their pursuit of making their country an "intelligent island" that

expands on its unprecedented economic growth that began in the 1990s (Warschauer,

2001).

Critical Thinking Skills for Students

Twenty-first century skills are important for students, teachers, and parents to

learn so that society can continue to move forward in terms of producing intelligent,

responsible citizens. To prepare to teach these skills using mobile devices, teachers will

have to take the digital literacy of their students into account for every lesson, meaning

that students are taught to access data from technology-based devices and then

manipulate and evaluate what they create on those devices (Jones & Flannigan, 2006).

In addition, parents and teachers are especially concerned about ensuring that students

are developing skills to become expert thinkers and to demonstrate complex

communication skills in order for the children to eventually support their own families

(Jerald, 2009).

Because these skills have to be practiced and refined regularly at home and

school with both peers and adults, students cannot take these skills for granted. In

addition, to better grasp how students are gathering and creating information, educators

should pay attention to the manner in which students use social media tools such as blogs, wikis, podcasts, and social bookmarking tools (Robin, 2008). This requirement to observe students' technology-based behaviors means that teachers, parents, and administrators have to develop a new mindset about the way that education is delivered and assessed. Further illustrating this point, revised admissions policies for universities in Singapore illustrate the government's attention to ensuring that their two pillars of education reform—thinking skills and information technology—become a reality for the country's students (Warschauer, 2001).

Mobile Learning and Critical Thinking

Today, the Internet is ubiquitous. On one hand, students have been raised in a technological environment so they do not know anything different; on the other hand, teachers, administrators, and parents have had to adjust to the ever-present use of technology because they were not raised in that type of setting. Most countries are teaching these skills not as separate subjects but rather as part of the curriculum (Ananiadou & Claro, 2009). In order to bring subjects together effectively, researchers are learning from each other about best practices for developing curricula-based teaching for these skills to avoid a "Tower of Babel" situation in which there is a uniform language and not a situation in which instructors end up using different terms with different meanings, which destroys the process of constructing knowledge (Dede, 2010).

One of the major shifts in how these skills are being taught can be seen in how teachers are moving from the linear, step-by-step process of the original version of Bloom's taxonomy, in which students learned subjects in building block fashion, to a

series of learning events that are out of order and meant for the students to construct

knowledge on their own (Silva, 2008). Teachers now have to view students from a

digital literacy perspective and therefore must apply elements of critical thinking to each

of the subjects that they teach (Jones & Flannigan, 2006). If subjects continue to be

taught in a traditional, sequential manner without an emphasis on nonlinear thinking,

students will find themselves unprepared for jobs requiring in-depth problem solving on

multiple levels: Because computers are being programmed to complete those types of

building-block tasks, people are being phased out from many types of jobs that do not

require higher-level thinking skills (Jerald, 2009).

Assessing Critical Thinking with Mobile Devices

The teaching of 21st century skills itself is not enough for a successful education

system. Instead, teachers have to demonstrate effective methods for students to assess

their own progress in understanding and applying these skills, alongside methods that

will allow teachers and parents to determine how well students have mastered the

learning objectives being taught in classes, both in the moment and over time. One of

the challenges that this study addresses is assessing the manner in which students

learn these skills. Teachers are constantly discovering new ways to determine the

effectiveness of their teaching methods for 21st century skills, while students are doing

the same thing from their own perspectives. Some specific concerns about the manner

in which these skills are assessed include the cost, time demands, and difficulty of

scoring exams covering these skills, which are difficult to quantify (Silva, 2008).

Still, some experts believe that assessing 21st century skills is too big a problem

to overcome, saying that the drive to teach higher-order thinking skills is nothing new

and that this approach weakens the delivery of core content (Silva, 2009). This argument has merit because the purpose of any education must be to provide students with the ability to solve problems on their own. Technology is one way to accomplish this goal. Accordingly, there is a greater need for teachers to motivate and engage their students in learning new content with multimedia technologies (Robin, 2008). The process of learning new content also means a new approach to assessing how well the content was understood by the students. Since the accreditation process for higher education is becoming standardized across borders, educators need to develop consistent educational benchmarks in order to produce students who can learn anywhere and anytime, based on the requirements of their jobs (Altbach & Knight, 2007).

Mobile Learning

Definition

Mobile devices are tools that can be used to teach students how to develop critical 21st century skills, such as collaboration, communication, artifact creation, and self-directed learning (Khaddage, Norris, Soloway, & Knezek, 2014). When mobile devices are combined with a preference for ubiquitous learning, the new term becomes mobile learning or *m-learning* (Jairak, Praneetpolgrang, & Mekhabunchakij, 2009). The portability of the device is an important factor in defining mobile learning. For instance, Traxler (2005) views mobile learning as "any educational provision where the sole or dominant technologies are handheld or palmtop devices," which could include "phones, smartphones, personal digital assistants (PDAs) and their peripherals, perhaps tablet

PCs and perhaps laptop PCs but not desktops in carts and other similar solutions" (pp. 262-263).

Mobility of the Learner

In essence, the portability of the device leads the way for the portability of the educational experience. To make this point about the partnering of portability with the educational experience, Norris and Soloway (2011) note that a smartphone or a tablet that weighs two pounds or less with a screen of 10 inches or smaller is a mobile device. The distinction that Traxler (2005), along with Norris and Soloway (2011), make about the size and weight of the device in differentiating between those that can be held in a hand and those that require a desk or table is important in terms of students being able to access the technology in an informal way, both at school and at home.

With this more complete definition of mobile learning, which incorporates the size of the device, the focus can turn toward the value that these devices afford modern students. For example, Prensky (2001) makes the point about the value of learning with a mobile device, stating that "as a result of this ubiquitous environment and the sheer volume of their interaction with it, today's students think and process information fundamentally differently from their predecessors" (p. 1). In order to think and process information in today's environment, in which people are bombarded with data at all times, Traxler (2005) characterizes mobile learning experiences as spontaneous, private, portable, situated, informal, bite-sized, light-weight, and context-aware, in addition to connected, personalized, and interactive (p. 264).

Learning with Mobile Devices

Applying Traxler's characterizations of mobile learning experiences to the classroom requires a new way of thinking about how to teach while using mobile devices as the foundation of the lessons. Cochrane (2010) provides an example of this new way of thinking about teaching with this list of critical factors needed to successfully implement a mobile learning lesson:

- importance of pedagogical integration of technology into course assessment,

- lecturer modeling of pedagogical use of the tools,

- need for regular formative feedback from lecturers to students; and

- appropriate choice of mobile devices and software to support the pedagogical model underlying the course.

Prensky (2001) uses the term *digital natives* to describe students who have spent their lives surrounded by video games, computers, digital music players, cell phones, and instant messaging to the extent that the mobile devices that bring these features have become part of their daily lives. The students whose responses were analyzed in the current study can be considered digital natives, according to Prensky's definition. As mobile learners, students can find ways to make the devices work in their favor from a learning standpoint. For instance, mobile devices enable students to catch up on work that was missed, improve understanding of challenging concepts, and offer a convenience while doing these things because those activities can take place anywhere (Litchfield, Dyson, Lawrence, & Zmijewska, 2007).

Deep Learning with Mobile Devices

The actions of students collecting, sharing, creating, and exchanging information are forms of active learning—a primary goal of any educational experience. These

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active learning strategies can be found in mobile learning classes, in which devices are used for polling students, gathering data from real-time questions, showing animated slide presentations, and offering remote audio and viewing access (Weber, Yow, & Soong, 2005).

Gathering information as Weber et al. (2005) described opens up new engagement strategies for teachers and learning opportunities for students to critically view each other's opinions in a constructive manner. In addition to gathering data, smartphones in classrooms democratize the creation of information through blogs, personal Web pages, podcasts, and wikis (Beetham & Sharpe, 2013). Creating information with the use of mobile devices brings about a collaborative, thought-provoking environment for teachers and students.

Context and Mobile Learning

In this age of mobility, the concepts of connectedness, being global, and affordability characterize our current state of learning with technology (Norris & Soloway, 2011). The pathway to today's mobility began in the mid-20th century with items such as paper, chalk, overhead projectors, and televisions—all examples of resources that were cutting edge in their respective times (Beetham & Sharpe, 2013). The use of paper, chalk, and overhead projectors brought mobility to learning in that students were then able to move to different locations in a single building for distinct learning purposes rather than having to remain in one room.

Effectiveness of Mobile Learning

The research questions in this study focus on understanding the students' and parents' positive perceptions about using smartphones for learning. Therefore, it is

important to know about results from similar studies that have also examined students'

and parents' positive perceptions about using smartphones in an educational setting.

One such study from Thailand found that more than half of the 390 college students

who participated in the project demonstrated a favorable view of mobile learning (Jairak

et al., 2009). However, a favorable view toward mobile learning does not necessarily

mean that students will automatically use smartphones to achieve educational goals.

For instance, an Australian study found that students raised with mobile devices have a

tendency to focus on the entertainment and personal communication features, as

opposed to using them for learning purposes (Kennedy, Judd, Churchward, Gray, &

Krause, 2008). One strategy to help students view the devices as learning tools instead

of strictly entertainment or personal communication tools is to attract their attention

through inquiry-based learning experiences.

<div align="center">Inquiry-Based Learning</div>

Definition

One aspect of the learning environment that the students in this study

experienced in their classes is known as inquiry-based learning (IBL). This learning

theory, also referred to as inquiry-guided learning or guided inquiry, presents students

with a question, an observation, or a hypothesis that will be tested and developed into

an answer through a series of predefined tasks (Prince & Felder, 2007). In inquiry-

based learning, the action of asking questions makes the learner think about the subject

from different angles and on multiple levels of cognition. Going through this kind of

learning process encourages students to think critically and to reflect on what they see

and how they process their observations. Put another way, this type of learning

engages students by requiring them investigate a learning space in order to determine all of the factors that are relevant to solving the problem (Kirschner, Sweller, & Clark, 2006).

Philosophy of IBL

Compared to traditional methods of teaching, inquiry-based instruction allows more time for students to fully investigate problems; this approach also transforms the teacher's role from a lecturer to a guide (Thacker, Kim, Trefz, & Lea, 1994). This type of instruction offers additional benefits for students by providing them with time to reflect on their thoughts, as opposed to what they are used to in traditional methods of teaching, where they are expected to simply memorize facts and quickly provide answers. As the students and teachers adapt to these new roles and way of learning, the educational experience should become more in-depth and cause students to change how they view problems and ways of solving them. One of the main benefits of inquiry-based learning is to bring educational experiences into authentic settings (Shih, Chuang, & Hwang, 2010). The use of mobile devices is ideal for enabling students to go into authentic settings, such as parks, zoos, and homes, in order to provide more enriching learning experiences.

Application of IBL

Inquiry-based learning has its roots in people's natural curiosity to discover how something works or why it appears the way it does. Once information is gained about a subject, then more questions arise from each discovery. The student controls the number of levels that will be inquired about on a topic based on factors such as time, interest, and the availability of research tools. However, that control should be shared to

a degree with instructors, librarians, or subject matter experts in order to help guide the learning experience (Chu, Tse, & Chow, 2011).

Control is not the only factor that defines this approach to learning. In fact, many of the concepts from inquiry-based learning derive from experiential learning (Healy, 2005). By having students experience learning first-hand, this form of learning is different from the traditional model, in which the teacher stands in front of the class and all the students read facts and opinions from their textbooks. The experiential, inquiry-based learning model is nonlinear in design, while the traditional way of learning uses the building block approach in a sequential manner.

Mobile Devices and IBL

However, in order for true inquiry to occur, it is important not to rely solely on the smartphones to create the learning setting. This means that teachers, not technology, remain the key component in the educational experience in an inquiry-based learning environment (Blumenfeld, Soloway, Marx, Krajcik, Guzdial, & Palincsar, 1991). Moreover, it is easy to be carried away with the features that technology offers in making artifacts look interesting and fun. However, without a guide or a sound basis in pedagogy for the lesson, the interesting and fun aspects of mobile devices by themselves will not create the deep learning experience that students need.

While many factors might impact an investigative process, research has shown that two factors—observation and manipulation—have positive effects on knowledge and understanding in an inquiry-based learning project as part of a mobile-technology-supported environment (Liu, Peng, Wu, & Lin, 2009). The use of observations and

manipulations with mobile devices becomes an important part in developing meaningful mobile learning experiences with inquiry-based learning as the foundation.

Because mobile devices afford students the opportunity to observe and manipulate ideas, objects, and data, the primary purpose of mobile- and inquiry-based lessons is to provide guidance in teaching students how to cognitively work with the data from multiple perspectives in order to achieve the learning goals and to store the results in long-term memory (Kirschner et al., 2006). For instance, some students might be hesitant to make observations based on data coming from their smartphones or to manipulate their mobile devices in order to move forward with experiments or exercises because they lack the confidence in using those tools for learning purposes. Other students might want some direction from the teacher and simply enjoy the freedom that mobile devices afford for creating artifacts, which then leads to developing hypotheses and testing them based on what they find in the mobile learning research process.

One study in a Hong Kong primary school examined students' technical knowledge of using mobile devices for learning purposes; researchers found that students' information literacy and IT skills improved as a result of completing two collaborative inquiry- and problem-based projects (Chu et al., 2011). As this study demonstrates, mobile devices are a good fit with the goals of inquiry-based learning. This fit between technology and learning theory happens because these devices promote the kind of active learning process in which students analyze the content from the smartphones or tablets in order to achieve learning goals, regardless of the time or place (Shih, Chuang, & Hwang, 2010).

Students, Mobile Devices, and IBL

With the use of mobile devices, whatever the student uncovers to solve the problem at hand becomes the basis for the learning experience. In this way, students become directly involved in the research process with inquiry-based learning (Healy, 2005). Understandably, with the more frequent use of smartphones in classrooms, as is the case in this study, the power in education has begun to shift to be student-centered, which can be a natural result of the inquiry-based process. Moreover, the power of mobile devices to empower students has been shown to contribute to the learning process in the following six ways:

- Enhance interest in the project due to authenticity, the type of challenge, or the value of the question.

- Access information from the Internet and peers, not just from teachers in the traditional sense.

- Show active representation of sounds, videos, colors, and graphics in multiple modalities.

- Structure the process through various cognitive and metacognitive strategies in the pursuit of gathering, manipulating, and integrating data as work is completed through phases of the project.

- Diagnose and correct errors in different parts of the process to analyze one's own investigative skills.

- Manage complexity and aid production by minimizing detail through generating artifacts on the mobile device. (Blumenfeld et al., 1991)

As part of the inquiry-based learning process, students will need to move from the classroom to their homes and to other places in a smooth, seamless manner. The next section discusses the value mobile devices bring to a seamless learning environment.

Seamless Learning

Definition

Students in this study also experienced seamless learning (SL), which focuses on the ability of students to learn and form ideas across multiple environments, whether it is the classroom, the home, or anywhere else. The continuity of learning from one space to another marks the concept of seamless learning, in which students go from formal to informal settings, along with individual and social ways of gaining knowledge (Looi et al., 2010). There are no distinct barriers in a seamless learning environment, so students find themselves learning even when they are not focused on achieving a specific educational goal. The ease of access to information on any subject in text or multimedia form provides students and teachers with many choices in pursuing knowledge.

Seamless learning provides unique educational opportunities for students and teachers to gather and assess data. Wong (2012) believes that in a seamless learning environment, students should aim to build knowledge and view information gained from online resources as support for making sense of data and constructing knowledge. That knowledge-building process happens outside the formal classroom in places such as afterschool care, museums, and other learning spaces in which students become exposed to different types of data (So, Kim, & Looi, 2008). In these learning spaces,

students place themselves in a thought-provoking environment that allows them to test their inquiry-based hypotheses and assess what they have learned.

Philosophy of SL

The philosophical roots of seamless learning come from many different types of social learning concepts, including discourse, communities of practice, collaborative learning, and internalization of social processes; seamless learning also stems from participation in joint activities as well as cultural, cognitive, and media literary contexts (Chan et al., 2006). Furthermore, in a seamless learning environment, the process of learning is supported by theories of situated learning, social learning, and knowledge building to influence the nature, process, and outcome of the educational experience (Looi et al., 2010). This combination of learning theories provides an ideal setting for using mobile devices because of the freedom of movement and creation afforded by the technology.

However, just because the learning resources are available to the student does not mean that he or she will engage in a learning quest all the time. For instance, Wong and Looi (2011) made the point that the role of seamless learning is not to have the student learning all the time but rather to provide a deep learning experience when the student is motivated to gain knowledge or look at a problem from a new perspective. Also, the timing aspect of seamless learning is the key, as students are able to switch from one scenario to another using a mobile device as the mediator to create the learning experience (Chan et al., 2006). In fact, students are using their mobile devices on a regular basis, and therefore supporting their own seamless learning experiences by accessing Web content and collecting artifacts such as photos, voice recordings,

daily notes on activities, and communication with peers via Skype and text messages (Boticki & So, 2010). This blending of learning experiences helps teachers to create more effective learning strategies based on mobile devices.

Application of SL

The teacher's role in a seamless learning environment is to provide the students with more questions and different perspectives to view the data, the hypothesis, or the situation. In support of this point, the research team of So, Kim, and Looi (2008) developed the following guidelines for creating seamless learning scenarios:

- Learning is not bounded by a fixed time or location.

- Mobile devices are used in diverse subject areas for integrated curricula.

- Learners construct knowledge and skills individually and collaboratively.

- Mobile devices are used to support experiential learning experiences.

- Knowledge is applied in situated contexts.

In addition, a study on teaching the Chinese language using a design called *Mobile Assisted Language Learning*, which used smartphones in a 1:1 ratio with the students capturing real-life photos related to idioms in the language, indicated that this seamless learning experience was successful in revealing the students' cognitive processes and learning strategies during the content creation (Wong, Chin, Tan, & Liu, 2010). By placing the learning situation in an authentic context that extended beyond the classroom, students were able to add meaning to their studies in a unique way. However, in order to stimulate debate among students, teachers should be patient and slow in providing answers or clues when they see students struggling to find answers on their own, especially in a seamless learning environment supported by mobile devices

(Wong et al., 2010). This patience on the teacher's part will come more easily as more mobile devices are used in these types of learning environments.

Students, Mobile Devices, and SL

Wong (2012) notes how a technology-supported learning environment provides a seamless learner with the opportunity to investigate, identify, and take advantage of many opportunities in the daily living space, as opposed to being limited by strictly defined learning goals and resources from a formal classroom setting. Using a smartphone or a tablet, the student can communicate with people who have similar interests in the subject in a community of inquiry. Communicating with people with similar interests in solving a common problem can lead to an exchange of ideas and artifacts that can lead to redefining the problem, using multimedia tools to visualize different viewpoints in the investigative process, and gaining new insights into how to assess one's conclusions.

Additionally, in an extensive literature review of a seamless mobile learning environment, Wong and Looi (2011) identified 10 salient features of how mobile technology creates the seamless effect, which can be observed in the current study:

- Encompassing formal and informal learning

- Encompassing personalized and social learning

- Learning across time

- Learning across locations

- Ubiquitous knowledge access (a combination of context-aware learning, augmented reality learning, and ubiquitous access to online learning resources)

- Encompassing physical and digital worlds

- Combined usage of multiple device types (including "stable" technologies such as desktop computers and interactive whiteboards)

- Seamless and rapid switching between multiple learning tasks (such as data collection + analysis + communication)

- Knowledge synthesis (prior and new knowledge, as well as multiple levels of thinking skills and/or multidisciplinary learning)

- Encompassing multiple pedagogical or learning activity models (p. 9)

The learning value that comes from seamless learning environments is expected to contribute greatly to helping students acquire 21st century critical thinking skills, which will be covered in the next section.

<div align="center">Self-Directed Learning</div>

Definition

Self-directed learning (SDL) requires the student to be in charge of his or her learning experience. For instance, the self-directed learning experience is made even richer with all of the social media tools and Web 2.0 technologies available where students can create informal discussions, reflective dialogues, and insightful content in a collaborative environment that allows students to understand the perspectives of others (McLoughlin & Lee, 2010). One way of gaining those perspectives can be achieved by following Kannan and Macknish's (2000) nine qualities of self-directed learning:

- knowing when to seek help from the tutor and/or peers,

- seeking other sources of help,

- setting goals,

- recognizing strengths and weaknesses,

- understanding the importance of learning from mistakes,

- having an inquiring mind,

- learning through discovery,

- working at one's own pace and managing time effectively, and

- making decisions (p. 8).

In order to engage in self-directed learning, the student should first go through a self-reflective, analytical process in order to gain self-knowledge, which serves as the foundation for lifelong learning (Kay, 1997). Self-knowledge comes from knowing what motivates a person; one study of an online course for college students in China found that a student's motivation was an overriding factor when compared to other factors such as self-directed learning, feedback, and technology (Kannan & Macknish, 2000).

Philosophy of SDL

Self-directed learning can be found in any type of learning experience that features a person taking on the responsibility of formulating a question and then gathering and analyzing information to develop an answer to the question. Some researchers see a correlation among self-directed learning and learning concepts such as self-determination theory, learner autonomy, and metacognition (Vandergrift, Goh, Mareschal, & Tafaghodtari, 2006). The basis of self-directed learning is to provide the student with the skills, discipline, and mindset to become a lifelong learner who sets

personal goals and creates plans for achieving them (Kay, 1997). These concepts of learning place the student at the center of the learning experience. Regardless of the subject, being able to learn throughout a lifetime will serve students well in any job or personal challenge.

In addition, the constant flow of online groups and technology-based applications (apps) for mobile devices helps students to go beyond the walls of traditional classrooms in order to direct their own learning experiences by participating in communities through the generation of content (McLoughlin & Lee, 2007). The creation of content requires higher-order thinking skills and a desire to exchange ideas with others. Those complex cognitive skills found in problem-based learning, once practiced over a period of time, end up becoming lifelong coping and critical thinking skills (Colliver, 2000). Then, the student can develop a learning cycle of his or her own by applying learning discipline to academic and personal subjects in order to become educated on any topic.

Application of SDL

Rather than just having teachers use technology to show that they enjoy working with the features and aspects of what can be done in that type of environment, lessons should provide learning based on sound pedagogical principles to facilitate an in-depth exchange of ideas among students (McLoughlin & Lee, 2010). In other words, there has to be an appropriate amount of worked examples, guidance, and demonstrations from the teacher, based on the knowledge levels and experience of the students in the class, in order to guide the students on the path to achieving the learning objectives.

In order to ensure that self-directed learning takes place in Singaporean schools, as is the case in this study, teachers have to first consciously move away from the traditional drill and practice method of teaching (Ziguras, 2001). Making this type of adjustment in the education system requires parents and teachers to agree that a cultural change takes place, not just a difference in the way the classes are managed. Still, it is clear that more research on self-directed learning is needed in order to better understand how to create techniques for teachers to teach and students to learn, especially given today's technology-based learning environments (Colliver, 2000).

Mobile Devices and SDL

In order to better understand the significance of the results of this study, investigating how the Singapore government called for the application of self-directed learning in a technological setting through its *Masterplan for IT* is an important first step. (Ziguras, 2001). Self-directed learning used with a mobile device makes the school, the home, and every place in-between a potential area for learning. There are many options that a mobile device offers students engaged in a self-directed learning process, which can take place either with the Internet, with apps on a phone or tablet, or with programs resident on a device.

In a self-directed learning experience with a mobile technology device, it is important to have a clear goal of the question to be answered or what subject should be investigated, as opposed to spending time aimlessly looking through the never-ending supply of data found on the Internet. Self-directed learning with mobile devices is also known as Pedagogy 2.0—a term that refers to a radical transformation in teaching and learning practices that gives students more control over what they learn, how they learn,

and when they learn in a technology-based, collaborative environment (McLoughlin & Lee, 2007).

There are now many more paths to gaining knowledge and exchanging ideas than at any other time in history. Mobile devices help students to search for knowledge and gain new understanding without the explicit direction or intervention of an instructor (Park, 2011). This freedom in thought could lead students to develop questions that they might not have thought of previously in a traditional classroom setting. The freedom to discover also shows the student that the learning experience does not fall neatly into the hours of a class but rather that knowledge building extends beyond the walls of the school.

Parental Involvement in Mobile Learning

The involvement of parents in a child's educational environment is critical to the success of the learning process. For instance, one study identified three main constructs related to why parents become involved in their child's academic performance:

- Role construction—the parents' beliefs about what they should be doing to support the child's learning
- Sense of self-efficacy—the parents' confidence levels in being able to actively help, mentor, or contribute worthwhile knowledge to the child
- General invitations, demand, or opportunities for involvement—the parents' perceptions that the child and the school want them to be involved (Hoover-Dempsey & Sandler, 1997)

In addition, researchers have found that parents can positively influence the child's educational experience by working through one or more of the constructs in the form of modeling, reinforcement, and instruction in collaboration with the teachers and the school's expectations (Hoover-Dempsey & Sandler, 1995). Still, evidence shows that the parents become positively influenced by the extent to which the school invites their participation—or on the contrary, does not look for parental involvement, which ends up having a negative impact on the child's learning process (Hoover-Dempsey et al., 2005). For instance, a study of the perceptions of eighteen parents in a Massachusetts elementary school found that the development of a trusting relationship in which the parents felt connected to and respected by the school staff led to more parental involvement and concern for the learning outcomes of the respective children (Mapp, 2003).

Parent Involvement and Student Achievement

One study conducted a needs assessment survey of inner-city parental involvement in school, and revealed that parents were concerned about their children and their children's education and appreciated the time, effort, and energy that the teachers used in their jobs (Hara & Burke, 1998). Therefore, determining what specific steps that parents can take to positively impact the academic performance of their children and to support their schools is of critical importance to communities all over the world. The first step that parents can take to help their children in school starts with a high-level view as opposed to a ground-level view. Research shows the two factors that impact academic performance the most are

- parental focus on a global level, as in overall GPA, rather than a specific

  level, such as a math class grade; and

- parental involvement through the expression of high expectations, as

  opposed to close supervision of work (Fan & Chen, 2001).

These two factors are supported by a meta-analysis of 41 studies examining the

relationship between parental involvement and academic achievement of urban school

students, which found that parents who focused in more general ways to create high

scholastic expectations, foster an environment of learning at home, and involve

themselves in the whole educational process exerted the greatest positive influences on

the child's learning outcomes, as opposed to implementing specific actions such as

attending school functions, establishing rules for the home, and checking homework

(Jeynes, 2005). Having structure in the home seems to have a positive impact on a

student's achievement, and as a result, is worth investigating in this study. Taking

parental involvement a step further, research shows that voluntary parental involvement

has a more positive impact on student achievement than when a school compels the

parents to become involved (Jeynes, 2007).

Parents and the Learning Process

The perceptions parents have about their children's educational

accomplishments revealed in this study are important for educators to hear. Most

parents want to know how they can best influence their child's educational experience;

however, teachers do not often have the time or the resources to provide that

information (Hill & Taylor, 2004). To address that concern, Comer and Haynes (1991)

reinforced the idea that unlike teachers, who may or may not live in the community,

parents bring a natural perspective about what is happening in the neighborhood along with an understanding of the children, collectively and individually, that schools should acknowledge. In addition, one of the major influences on parents' perceptions about school comes from conversations with other parents, in which everyone begins to understand each other better, which in turn creates a forum that serves as a social constraint and a way of preventing problem behavior in the classroom before it starts (Hill & Taylor, 2004). With less problem behavior there is a greater opportunity for the student to use the mobile device to pay attention to the subject.

Of further relevance to this study, researchers have found that when parents are involved in the educational process, there is a positive impact on the (a) students' attitudes about homework, (b) perceptions of personal competence, and (c) abilities to implement self-regulatory strategies (Hoover-Dempsey et al., 2001). One study, which interviewed 253 former Head Start parents, showed that the extent of parental involvement in schools was derived from the parents' views of the school climate and their beliefs in their abilities to positively influence their child's educational experience (Seefeldt, Denton, Galper, & Younoszai, 1998).

Another reason for understanding the parents' perspectives in this study is that parents and teachers need to look at the influential factors they can exert to help students succeed in school. One influential factor is parental self-efficacy, and it is important to define this term. The term self-efficacy deals with perceived capability (Bandura, 2006). The main reason for focusing on the perception of parents' self-efficacy is because evidence shows that focusing on a student's knowledge and skills alone to improve academic performance may not be enough because the parents must

have confidence in their own abilities to carry out their responsibilities (Coleman & Karraker, 1998). A student's self-efficacy process begins at an early age when parents provide an environment that stimulates the child's curiosity and allows for mastery experiences in confidence development (Schunk & Pajares, 2001). The student's perception of efficacy starts with high expectations of academic achievement set by the parents, and then it turns into a sense of assurance as the student regulates his or her own learning and academic attainments (Bandura, Barbaranelli, Caprara, & Pastorelli, 1996).

According to Coleman and Karraker (1998), "Parental self-efficacy beliefs embody an estimation of the degree to which parents perceive themselves as capable of performing the varied tasks associated with this highly demanding role" (p. 47). Parental self-efficacy involves a tremendous amount of pressure due to the heavy demands of coping with children as they grow older, along with having to maintain relationships within the systems of family, education, recreation, medical, and caregiving facilities (Bandura, 1995).

<div align="center">Achievement Scores</div>

Factors Influencing Achievement

The results that come from a student's achievement tests in a given subject should provide a valid and reliable assessment of what the student has learned. However, evidence indicates that the pressure teachers are under to make sure their students score high on these tests often results in inflated scores. In addition, there also seems to be a lack of accountability on the instructor's part to see that students actually learn the subjects being tested (Koretz, 2002). Therefore, a new way of learning should

<div align="center">37</div>

influence teachers to first fully understand their own motives in creating their lesson plans in terms of serving their own needs to have high scores behind their reputations or in making sure that all of their students achieve the learning goals, not just that students will achieve high scores on their standardized tests.

While analyzing their motives for teaching, instructors must also be aware of the impact that different teaching environments have on the educational experiences of the students. For instance, a blended e-learning class might make up for some shortcomings of a traditionally taught class, in which case the teacher should use different ways to carefully assess to what extent each student achieved the stated learning goals (Chang, Shu, Liang, Tseng, & Hsu, 2014). These results point out the necessity for teachers, administrators, parents, and students to circumvent the trap of becoming so influenced by the features and excitement of new technology that sound pedagogy is no longer a priority. In addition, researchers should seriously investigate the impact that students' emotional states have on achievement scores. One study found that "academic emotions are significantly related to students' motivation, learning strategies, cognitive resources, self-regulation, and academic achievement, as well as to personality and classroom antecedents" (Pekrun, Goetz, Titz, & Perry, 2002).

Since students do not learn in a vacuum, two of the most important factors in a student's academic success are parents and schools. Researchers have shown that a school's effort to involve families and the community in the learning process leads to increased achievement scores (Sheldon, 2003); hence, the notion that the learning process is complex with a strong social component. The frequency of giving students achievement tests has been investigated to determine whether they are a factor in

determining student scores and to examine their feelings about their academic performances as reflected in the tests. One study that found that the frequency of standardized tests did not convert into higher scores nor did it decrease student anxiety about taking the tests (Ramshe, Barati, & Youhanaee, 2014). These results mean that educators must go beyond the concept of rote training and focusing on repetition in order to see higher achievement scores.

An important way that schools can influence students to make higher scores on achievement tests is by noting the communication styles of teachers in the classroom. For example, teachers should pay attention to their facial expressions, body language, and nonverbal cues in order to convey that the classroom is a safe learning environment and to avoid situations where students might misinterpret messages from their teachers (Nyroos, Jonsson, Korhonen, & Eklöf, 2015). This recommendation highlights the fact that learning involves social and psychological components, along with cognitive factors.

Improving Achievement

The question of strategies to improve achievement is a cornerstone of this study. At this stage in the students' academic careers, achievement tests will play an important role in deciding the level of difficulty of future classes for each student. With that in mind, while students at all levels can benefit from the involvement of parents, teachers, and the community in the educational process, students in lower grades such as K-3 seem to benefit in terms of increased achievement scores (Sheldon, 2003). The involvement of parents, teachers, and the community provides a well-rounded approach in terms of having the student see different perspectives of concepts taught in class.

In looking at specific strategies to improve K-6 student achievement scores, one intervention method involves the concept of failure in the educational process. Researchers have found that when teachers present the notion of failure simply as an accepted part of the learning process, then students would decrease their fear of failure, which is an indicator of anxiety (Nyroos et al., 2015). While it might be difficult for some students to accept failure in the learning process, being able to recognize it and continue moving forward toward achieving the learning objectives is critical for future academic success.

In addition, the teacher will need to have the patience to not just supply the student with the answers when he or she is struggling, but also to understand that the students need to experience the full range of emotions—happiness, sadness, anger, and excitement—in order to prove to themselves that they have the strength and conviction to complete the assignment. In terms of the amount of time that a teacher spends on a subject, one study found that teachers who spent more time in a content area had students who achieved higher levels than teachers who spent less time in the same area (Fisher et al., 1981).

Student Perceptions About Achievement

Another aspect of this study is to understand that students may wrap their academic identities in their achievement test scores. As a result, there could be too much focus from teachers and students on making sure that those scores are as high as possible. In order to ensure that students do not simply focus on achievement tests, some researchers believe that having a portfolio assessment system would be a good way for students to continue paying attention to the work that they create throughout

their school years and to present their body of work to teachers or administrators (Koretz, 2002).

An interesting argument can be made about comparing the results of achievement tests and the results of student self-assessments. For example, one study in Taiwan made this comparison in a study with e-learning and traditional ways of teaching and found that while the e-learning approach did not affect achievement scores, the approach did influence the students' self-assessment of their learning. The researchers noted that these results indicated that teachers should consider subjective and objective ways of understanding exactly what their students have learned in any given class (Chang et al., 2014). These two ways of thinking about what factors make up a student's understanding of material is important for researchers to understand.

Achievement Groups

The grouping of students based on performance on achievement tests is a controversial and important part of the Singaporean school system. Advocates for streaming, meaning placing students in homogenous groups based on achievement, believe that teachers can better customize lessons to meet the needs of high-achieving students while at the same time not frustrate the low-achieving students by moving too fast through explanations and topics (Liu, Wang, & Parkins, 2005). The teacher could move at a pace that was comfortable for all students and have the confidence that a majority of the students would have similar questions, as opposed to dealing with a situation in which some students were advancing through the lesson while others were stuck on the fundamental points. However, streaming has its critics, who believe that

placing students in these groups would serve to demotivate the students and hurt their self-confidence due to the labeling system (Kam & Gopinathan, 1999).

In 2008, the concept of streaming—which enabled students to move at their own pace starting in fifth grade—was replaced with the implementation of banding at the end of sixth grade, which placed students in three groups based on their performance on the Primary School Leaving Examination in four core subjects: English, math, mother tongue language, and science (OECD, 2010). By placing students in bands based on performance in these four core subjects, the students were given opportunities to move forward with peers at the levels based on the specific topics. One common point for all students, regardless of band, is the use of English as the primary language, which was chosen by the government in order to create a unique Singaporean culture, compared to one that is Indian, Malay, or Chinese (Rubdy, 2005).

Summary

The eight subjects covered in this literature review provided the context to analyze and evaluate the data from this study. Each of the subjects became linked to the next one as part of a complete story about the current change in the Singapore educational system, which is moving from a teacher-centered system to one that is student-centered. The purpose of this move to student-centered learning is to prepare students with the 21st century critical thinking skills needed to compete and thrive in today's global, technology-based economy. The smartphone is the primary tool used in this study because the researchers believed that mobile learning could be a key agent of change.

The learning process with the mobile devices is seamless, in that it now extends beyond the classroom into the students' homes and on field trips, walks through a park, or anywhere a student may go. The fact that learning takes place both in and out of school is meant to prompt students to ask questions about real-world problems and go through an inquiry process by themselves and with others. The collaboration and drive to solve problems are meant to motivate students to become engaged in a self-directed learning process in which they determine their learning goals and accomplishments.

A key factor in all of these learning processes is the parent. Each parent should find themselves in different roles, without having to come up with all of the answers. For instance, one role that a parent might play is that of a fellow problem-solver who comes up with different kinds of questions. Another role might be to drive the student to a museum or provide Internet access at home, so that the student can investigate problems and create artifacts independently. Finally, all of these learning experiences can be measured in a number of ways. One of the objective ways of measuring what a student has learned is through analyzing and evaluating achievement scores.

CHAPTER 3

METHODOLOGY

This chapter provides a description of the unique nature of this study in terms of deciding who the participants were, how the responses were collected, and how the resulting data were analyzed and evaluated. The uniqueness of the decision on how to choose the participants came from the fact that most of the data were based on the analysis of the parent/child relationship in terms of how they each viewed the learning process, featuring the smartphone as the primary learning tool. For example, student and parent responses were matched with each other, along with student achievement scores to those pairings. In addition, the use of Likert-based surveys for students and their parents provided direct knowledge of their thoughts and feelings about this particular mobile learning process, including a way of tracking students' progress in demonstrating knowledge as measured by the change in achievement scores from the middle of the year to the end of the year in English and science. Finally, emphasizing the data from low-achieving students reflected the interest in understanding what motivations or strategies can be applied in a mobile learning setting to help that student group better equip themselves with 21st century critical thinking skills.

This last point about focusing on improving the academic performance of low-achieving students highlights the need to focus significant attention on that group of learners. In Singapore, there is a three-level system of academic achievement groups and a teacher-centered classroom as opposed to a student-centered learning environment. In regard to achievement groups, the low-achieving students stand the best chance of seeing a major improvement in their academic performance with the

introduction of mobile devices in the classroom. In other words, the effective use of

mobile devices for learning purposes in the classroom and at home could be one factor

that ends up making a difference in the learning process that has previously not existed

for low achieving students. This study provides a look at that difference in the learning

process by measuring the gains for low-achieving students in academic performance.

Those gains in achievement could result in greater self-esteem among low-achieving

students in seeing themselves as learners who are just as capable as medium or high-

achieving students. Thus, the use of mobile devices as learning tools could help

instructional designers, teachers, and administrators move from a teacher-centric

learning process to a technology-based, student-focused classroom that extends from

the school building, to the home, and anywhere in between.

<div align="center">Participants</div>

The participants in this study were third-grade students and their parents from a

typical Singaporean elementary school that had agreed to participate in the WE Learn

Project. Starting in January 2010, The WE Learn Project followed the educational

strategies of the Masterplan 3 (MP3) for Education (Khaddage, 2014). The MP3 was a

program developed by the Singaporean government's Ministry of Education (2008). The

goal of the MP3 program was to move to an inquiry-oriented pedagogy from a direct-

instruction pedagogy (Khaddage, 2014).

In 2009, Dr. Cathie Norris and Dr. Elliot Soloway were involved with a team of

NIE researchers to explore the role that mobile might play in helping a school transition

from direct instruction to an inquiry pedagogy. The data for this study were collected in

2013 by researchers at the Singaporean elementary school. In 2015, Dr. Norris and

Dr. Soloway invited me to choose a specific topic within the data for use as the subject of this research project. In 2016, I completed the analysis for this study.

The Singaporean elementary school students in this study had not used smartphones for learning in school prior to entering the third grade. By the time the students moved into the third grade, both the science and the English courses were using smartphones for learning. Parents of these students were also notified that these two courses would use smartphones. The smartphones that were provided to the students were Nokia 710 and Nokia 625 devices that ran Windows Phone 7 and 8 (Khaddage, 2014). The phones had specific software programs preloaded onto them that would facilitate learning in the English and science classes.

Achievement Groups

This study provides insight into the way in which the introduction of mobile phones in the classroom and at home for learning might signal the start of a new set of academic expectations for each of the achievement groups, especially the low-achieving students. In order to see if this concept of new expectations for low-achieving students is merited, it is important to note that each of the three groups is broken down into classes, with the HA students being divided into classes A, B, and C; the MA students into classes E, F, and G; and the LA students into classes D and H. Rather than using data from all of the classes, the decision was made to focus on the HA and LA students and parents as the two populations because they represented both ends of the academic spectrum.

A one-way ANOVA was done in order to compare the mean scores of the three HA classes for changes in English and science exams from the midterm to the final. The

purpose of completing the one-way ANOVA was to see if there was a difference among the students in the three classes, in which case the classes would have to be analyzed individually, or if the classes could be considered as one large group. The significance for the change in the English scores was p=.390 and the change in science scores was p=.381). Since those results were greater than the standard threshold of p<.05 in order to be statistically significant, the conclusion could be made that there was no difference in the academic performance among students in the three classes. As a result, the data of the three classes were aggregated into one high-achieving group, labeled HA ABC. The results of the one-way ANOVA can be seen in Table 1.

Table 1

One-Way ANOVA for Classes HA ABC

		Sum of Squares	df	Mean Squared	F	Sig (*p*-value)
Change in English scores from mid-year to end-of-year	Between Groups	43.325	2	21.663	.950	.390
	Within Groups	2828.616	124	22.811		
	Total	2871.941	126			
Change in science scores from mid-year to end-of-year	Between Groups	69.574	2	34.787	.904	.381
	Within Groups	4286.243	120	35.719		
	Total	4355.817	122			

Note. HA = high achieving, *df* = degrees of freedom, *F* = observed *F* value, Sig = significance.

The data for the two low-achieving classes (D and H) were also examined for statistically significant differences to determine whether to combine the two classes into one group or to analyze them separately. In order to make that determination, a one-sample t-test was completed to compare the mean scores of classes LA D and LA H for the change in English and science exam scores respectively from the midterm to the

final. The results of this test showed that there was a statistically significant difference between the mean scores of the change in science exams (p = .000) for the two classes, which can be seen in the column labeled "Sig (2-tailed)" in Table 2. Therefore, the decision was made to include results from both classes separately, labeling them LA D and LA H.

Table 2

t-*Test for LA Classes*

		Levene's Test for Equality of Variances		t-Test for Equality of Means					95% Confidence Interval of the Difference	
		F	Sig	t	df	Sig (2-tailed)	Mean Difference	Standard Error Difference	Lower	Upper
Change in English Scores	Equal Var Assumed	4.902	.031	.766	61	.446	1.32796	1.73254	-2.13647	4.79239
	Equal Var Not Assumed			.718	40.839	.477	1.32796	1.85012	-2.40888	5.06480
Change in Science Scores	Equal Var Not Assumed	.474	.494	-4.503	56	.000	-8.04688	1.78693	-11.62652	-4.46723
	Equal Var Not Assumed			-4.440	50.080	.000	-8.04688	1.81242	-11.68709	-4.40666

Note. t = observed *t* value, LA = low achieving, *F* = observed *F* value, Sig = significance, *df* = degrees of freedom, Var = variance.

In order to better understand the performance levels of the classes, a one-sample *t*-test was performed for LA D and LA H (see Tables 3-6). In looking at the results for both classes, the main theme observed is an increase in science achievement and a decrease in English achievement.

Table 3

One-Sample t-*Test for Class LA D*

	N	*M*	*SD*	Standard Error of *M*
Change in English Scores	26	-1.4423	8.19918	1.60799
Change in Science Scores	26	.2500	7.26120	1.42404

Table 4

Change in English and Science Scores for LA Class D

	t	*df*	Sig. (2-tailed)	*M* Difference	95% Confidence Interval of the Difference	
					Lower	Upper
Change in English Scores	-.897	25	.378	-1.44231	-4.7540	1.8694
Change in Science Scores	.176	25	.862	.25000	-2.6829	3.1829

Table 5

One-Sample t-*Test for Class LA H*

	N	M	SD	Standard Error of M
Change in English Scores	37	-2.7703	5.56601	.91505
Change in Science Scores	32	8.2969	6.34220	1.12115

Table 6

Change in English and Science Scores for LA Class H

	t	df	Sig. (2-tailed)	M Difference	95% Confidence Interval of the Difference	
					Lower	Upper
Change in English Scores	-3.027	36	.005	-2.77027	-4.6261	-.9145
Change in English Scores	7.400	31	.000	8.29688	6.0103	10.5835

The MA students were not included in this study because it was assumed that adding them would diminish the difference that could be seen from comparing data of HA and LA students. Also, it was determined that HA parents' beliefs would offer a good contrast for the LA parents' beliefs. Evaluating the parents' beliefs is crucial in understanding how the mobile devices are accepted in the home in terms of supporting learning through those devices in a way that matches the encouragement in school.

Instruments

The instruments used in this study included a student survey, a parent survey, English achievement exam scores, and science achievement exam scores. This study matches the responses of the students, the parents, and the respective achievement scores to create a complete picture of attitudes and performance in one place. The student survey used in this study was given at the end of the school year, and was one of three Likert-based surveys that the students took that year. The end-of-year survey was chosen because there was not a need to see a change in attitudes throughout the year, rather just to see what the attitudes were by the end of the year. The goal of the student survey was to gain an understanding of what students think about using mobile phones for learning and how their perceptions range on a scale of positive and negative feelings regarding that kind of educational setting. The parent survey used in this study was taken at the end of the year and was the second of two surveys during the year in 2013. The main goal of the parent survey was to gain personal insights on the perspectives that parents had about their children using smartphones for learning.

Achievement Scores

The English and science exam scores used in this study were taken from the traditional standardized tests that all third-grade students in Singapore must take. Since a comparison of scores was needed for the analysis in this study, the scores from the middle of the year were compared with those from the end of the year for each student. In addition, rather than choosing to use scores from one

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subject for this study, the decision was made to include exam scores from both

science and English in order to see if there might be a difference in perceptions

and performance based on the subjects. The achievement exams were graded

on a scale of 0-100. The decision was made to remove a student's English

and/or science achievement score from the data used in this study if the change

in the score was either >19 or >-19 in order to remove the outliers from a

reasonable score range. The range of 19 was determined to be a reasonable

range because anything greater than 19 in either direction would likely indicate

that a greater number of factors that were not being analyzed in this study were

likely present. A breakdown of data used for HA students is shown in Table 7.

While there are variances in the *N* among questions due to some questions not

receiving a response, the breakout of the student data in the LA classes is

displayed in Table 8. While there are variances in the *N* among questions due to

some questions not receiving a response, the main breakdown of the HA parents

is shown in Table 9. The data for the parents of the LA students are shown in

Table 10.

Table 7

All HA Responses to Student Survey

Class(es)	Data Source	Number of Students in Class(es)	Number of Students in Analysis	Number of Students not in Analysis	% Participation	Reason Not in Analysis
HA A	Student Survey	43	26	17	60%	Students did not respond.
HA A	English Exams	43	43	0	100%	N/A
HA A	Science Exams	43	42	1	98%	One students score removed because change in score >19.
HA B	Student Survey	43	41	2	95%	Students did not respond.
HA B	English Exams	43	43	0	100%	N/A
HA B	Science Exams	43	43	0	100%	N/A
HA C	Student Survey	43	39	4	91%	Students did not respond.
HA C	English Exams	43	41	2	95%	Students were missing one of the two exam scores.
HA C	Science Exams	43	38	5	88%	Two students were missing one of the two exam scores; three students removed because change in score >19.
Total for HA A, B, & C	Student Survey	129	106	23	82%	Students did not respond
Total for HA A, B, & C	English Exams	129	127	2	98%	Scores not found
Total for HA A, B, & C	Science Exams	129	123	6	95%	Scores not recorded

Note. HA = high achieving.

Table 8

All LA Responses to Student Survey

Class(es)	Data Source	Number of Students in Class(es)	Number of Students in Analysis	Number of Students not in Analysis	% Participation	Reason not in Analysis
LA DH	Student Survey	64	62	2	97%	Students did not respond
LA DH	English Exams	64	63	1	98%	Scores not recorded
LA DH	Science Exams	64	58	6	91%	Scores not recorded
LA D	Student Survey	26	26	0	100%	N/A
LA D	English Exams	26	26	0	100%	N/A
LA D	Science Exams	26	26	0	100%	N/A
LA H	Student Survey	38	36	2	95%	Students did not respond.
LA H	English Exams	38	37	1	97%	Student missing one of the two exam scores.
LA H	Science Exams	38	32	6	84%	One student missing one of two exam scores; five students had scores >19.

Note. LA = low achieving.

Table 9

All Survey Responses from Parents of HA Students

Student's Class(es)	Data Source	Number of Parents	Number of Parents in Analysis	Number of Parents not in Analysis	% Participation	Reason not in Analysis
HA A	Parent Survey	43	31	12	72%	Parents did not respond.
HA B	Parent Survey	43	32	11	74%	Parents did not respond.
HA C	Parent Survey	43	25	18	58%	Parents did not respond.
Total for classes HA A, B, & C	Parent Survey	129	88	41	68%	N/A

Note. HA = high achieving.

Table 10

All Survey Responses for Parents of LA Students

Student's Class	Subject	Number of Parents	Number of Parents in Analysis	Number of Parents not in Analysis	% Participation	Reason not in Analysis
LA D	Parent Survey	26	8	18	31%	Parents did not respond.
LA H	Parent Survey	38	28	7	74%	Parents did not respond.
Total for classes LA D & H	Parent Survey	64	36	25	56%	N/A

Note. LA = low achieving.

All student and parent responses were aligned per student for analysis using SPSS. In other words, each student had his or her own line within SPSS that contained (a) student name, (b) student survey responses, and (c) parent survey responses for that student, (d) English exam 1 and 2 scores, and (e) science exam 1 and 2 scores.

Student Survey

Gaining the perspective of parents and matching them with the views of students about using mobile devices for learning is especially important considering that from a cultural standpoint, Singapore traditionally has a high respect for authority figures. For many years, the educational culture in Singapore has tasked teachers and parents with the responsibility of giving knowledge to students. The introduction of mobile devices in the classroom and in the home for learning purposes has the potential to develop a collaborative educational environment in which parents and students create knowledge together, rather than having knowledge going in one direction from parent to child.

The use of mobile devices in Singapore classrooms demonstrates the application of an inquiry-based educational system that is meant to generate creative and critical thinking skills. This focus on the inquiry process communicates a clear departure from the way that the learning process was carried out in the past. With such a major change in the teaching process, being able to gain the perspectives of students and parents about their attitudes towards mobile devices in the classroom is crucial to understanding how to

design future mobile learning curricula that engages students in deep learning

and motivates them to focus and pay attention to the learning goals. The student

perspectives gained for use in this survey included eight questions that came

from a larger student survey. The larger student survey is shown in Appendix A.

These eight questions listed were chosen because each question specifically

focuses on an aspect of using mobile devices for learning:

- Do you like using a smartphone for learning English?

- Do you have a smartphone?

- How many hours per week do you use apps or a Web browser on your smartphone?

- Would you like to use a smartphone for your schoolwork?

- Does using a smartphone in the classroom help you learn?

- Would you spend more time on your schoolwork if you used a smartphone to do the schoolwork?

- Do your parents approve of the use of smartphones for your schoolwork in your classroom?

- Would you like to have more mobile technology activities in your schoolwork?

Parent Survey

The study's consistency of matching a parent's survey responses with the respective child's survey responses was a cornerstone of the analysis. Unfortunately, not all of the original data had a perfect match for each child to his or her parent. In many cases, the parents did not provide responses, as opposed to only a few cases in which the students did not offer responses to their surveys. It is important to note that not all of the correlations have an *N* that equals all parent responses listed because some parents did not respond to certain questions.

The responses from the end-of-year parent survey used in this study came from 29 statements on a 45-statement survey. The larger version of the survey is shown in Appendix B. The 29 statements are grouped under six constructs. Those constructs were used in previous studies by the researchers who collected the data for this project. One statement was not included in the previous constructs and it is marked in this list. The six constructs are:

- ISP -- Parental perception of importance of smartphones,

- SPL -- Parental support for the use of smartphones for learning,

- ASP -- Parental support in giving child autonomy with smartphones,

- MC -- Parental action of monitoring/control,

- CL -- Parental perceptions towards child's learning using smartphones, and

- UL -- Uses of the smartphone for learning.

The survey statements that resulted in statistically significant correlations for Research Questions 2 and 3 are listed along with their construct categories. At the time this study was completed, there was no statistical data to indicate how the constructs were created.

- ISP – 9 Statements
  - Using a smartphone at home is more helpful than going to the library.
  - I can live without a smartphone.
  - It is important that my child has access to a smartphone at home.
  - It is important that my child has access to a smartphone at school.
  - My child uses the smartphone for help in completing his/her homework.
  - My child should be taught how to use a smartphone as much as he/she is taught other subjects like Math or reading.
  - It is important that my child learns how to use a smartphone so as to study and do his/her homework.
  - Knowing how to use a smartphone will help my child do well in school.
  - I get involved in my child's education with the help of a smartphone.
- SPL – 4 Statements
  - I support the use of smartphones for learning in school.
  - I support the use of smartphones for learning at home.
  - I support the use of smartphones for learning everywhere.

- All pupils in the school should use smartphones for learning.

- ASP – 6 Statements

  - I let my child plan what to do on the smartphone.

  - I am usually willing to consider things from my child's point of view when he/she works on the smartphone.

  - I am sensitive to many of my child's needs when he/she works the smartphones.

  - I am sensitive to many of my child's needs when he/she uses the smartphones.

  - I allow my child to choose what to do with the smartphone whenever possible.

  - I let my child decide what to do on the smartphone.

- MC – 6 Statements

  - My child shows me his/her work on the smartphone.

  - I ask my child to show me his/her work on the smartphone.

  - I know what my child is doing on the smartphone.

  - Parents should monitor their children's smartphone usage.

  - Parents should monitor their children's internet usage.

  - I get involved in my child's education with the help of a smartphone (was not included in previous constructs)

- CL – 1 Statement

  My child enjoys learning using his/her smartphone.

- UL – 3 Statements

- Games

- Surf the net

- Watch videos

Correlations

The primary analytical method used in this study was bivariate correlation analysis because it "tests whether the relationship between two variables is linear (as one variable increases, the other also increases or as one variable increases, the other variable decreases)" (Towson University, 2014). This project applied the Pearson correlation, which is noted as r, as in $r = .326$, for a given correlation between two variables (leardstatistics.com). A two-tailed test of significance with an acceptable level of $p < 0.05$ was also used in this project to determine which correlations would be analyzed. The p-value determines whether a probability is likely or not likely by assuming the null hypothesis—or the opposite of what was expected—were true with the goal being to determine if that null hypothesis is rejected in favor of an alternative hypothesis (Penn State Eberly, College of Science). A p-value that is less than 0.05 means that the null hypothesis was rejected. The null hypothesis in any experiment states that there is no relationship between the two variables being analyzed. A rejection of the null hypothesis, in this case having a p-value of < 0.05, means that there is a correlational relationship.

Summary

This chapter explained the manner in which the study's participants, students and parents, provided their beliefs about the use of smartphones for

learning. These beliefs were gathered by using a student survey and a parent

survey based on a 5-point Likert scale. In addition, the achievement scores of

English and science standardized achievement tests from midyear and the end

of the year were central parts of the correlations.

CHAPTER 4

RESULTS

The results of this study indicated that there are several relationships in which the positive attitudes towards using smartphones for learning have statistically significant correlations with academic achievement. Specifically, a few of the LA student and parent correlations with academic performance and with each other have the potential to point to new paths for designing mobile learning curricula. The analysis of the results began with the formation of these three research questions:

1. Is there a relationship between students' positive beliefs about using technology for learning and their increased achievement scores?

2. Is there a relationship between parents' positive beliefs about using technology for learning and their students' increased achievement scores?

3. Is there a relationship between students' and parents' positive perceptions about using smartphones for learning?

This chapter provides a detailed analysis of the results of the statistically significant correlations that developed from the responses of the different student and parent groups. While many correlations existed, the statistical significance of certain correlations was used as a way to distinguish the important relationships from a research standpoint from the ones that merely existed.

Research Question 1

The first research question focuses on the student's perspective of mobile devices in the classroom and achievement: Is there a relationship between students' positive beliefs about using technology for learning and increased achievement scores? The correlations with statistical significance related to English achievement are shown in Table 11 and the correlations with statistical significance related to science achievement are shown in Table 12.

Table 11

Correlations Between Student Survey Questions and English Achievement

Survey Question	Group where achievement was observed	*N*	Pearson's *r*	**p*-value
**Do you like using the smartphone for English classes?	LA Class D	26	.423	.032

Note. *Correlation is significant at the 0.05 level (2-tailed). Correlation is significant at the 0.01 level (2-tailed). **Survey response choices were: Yes/Depends/No. LA = low achieving.

Table 12

Correlations Between Student Survey Questions and Science Achievement

Survey Question	Group where achievement was observed	*N*	Pearson's *r*	*p*-value
Would you like to use a smartphone for your schoolwork?	LA Class H	30	.463	.010
Would you spend more time on your schoolwork if you used a smartphone to do the schoolwork?	HA Classes A, B, & C	102	.259	.008
Would you like to have more mobile technology activities in your schoolwork?	LA Class D	26	.403	.041
Would you like to have more mobile technology activities in your schoolwork?	HA Classes A, B, & C	102	.240	.015

Note. Correlation is significant at the 0.05 level (2-tailed). Correlation is significant at the 0.01 level (2-tailed).Survey response choices were: Yes/Depends/No.

Summary of Research Question 1 Results

One observation that can be made is that the Pearson *r* coefficients for the LA correlations in science (.463, and .403) are double what the HA correlations are (.259, .240) in the same subject. This means that the results show a stronger relationship between the variables in those correlations for the LA classes versus those relationships in the HA classes in science. A second observation is that the two LA correlations in science focus on activities related to the smartphone while the single LA correlation in English is based on the student liking the subject. This observation is especially meaningful when it is viewed in the context of the mean achievement scores for LA students, which increased in science and decreased in English. The mean scores for LA and HA students are listed in Tables 13, 14, and 15. The fact that science brings about an interest in doing something with the phone as opposed to just liking the subject reinforces the

inquiry-based learning model in that there is an active investigation of the subject of science. A third observation is the fact that the interest in having more science-based mobile activities correlated with an increase in achievement scores and was important to both LA classes (D and H) and the combined HA Classes (ABC) The mean scores showing the increase in science scores from mid-year to the end of the year are listed in Tables 13, 14, and 15 for the three groups.

Table 13

Class LA D Means for Scores in English and Science

		English Mid-Year	English End-of-Year	Science Mid-Year	Science End-of-Year
N	Valid	26	26	26	26
	Missing	0	0	0	0
M		46.942	45.500	39.538	39.788

Table 14

Class LA H Means for Scores in English and Science

		English Mid-Year	English End-of-Year	Science Mid-Year	Science End-of-Year
N	Valid	37	38	32	33
	Missing	1	0	6	5
M		59.324	56.671	61.203	69.742

Table 15

Classes HA ABC Means for Scores in English and Science

		English Mid-Year	English End-of-Year	Science Mid-Year	Science End-of-Year
N	Valid	128	128	124	124
	Missing	1	1	5	5
M		80.395	77.637	81.931	87.254

Research Question 2

The second research question focuses on the parent's perspective: Is there a relationship between parents' positive beliefs about their children using technology for learning and their children's increased achievement scores? The statistically significant correlations are listed in groups in Table 16.

Table 16

Correlations Between Parent Survey Questions, Classes, and Achievement Scores

Parent Survey Question	Group where achievement was observed	Class Subject	Pearson's *r*	*p*-value	*N*
†Please tick the 3 most common uses of the smartphone by your child at home: Games	HA Classes A, B, & C	Science	.228*	0.036	85
I am usually willing to consider things from my child's point of view when he/she works on the smartphone.	HA Classes A, B, & C	English	.246*	0.022	87
	LA Class H	English	.468*	0.011	29
I am sensitive to many of my child's needs when he/she works on the smartphones	LA Class D	Science	.879**	0.004	8
	LA Class H	English	-.383*	0.040	8
I am sensitive to many of my child's needs when he/she uses the smartphone	LA Class H	English	-.474**	0.009	29
I allow my child to choose what to do with the smartphone whenever possible.	LA Class D	Science	.740*	0.036	8
I let my child decide what to do on the smartphone.	LA Class D	Science	.713*	0.047	8
I support the use of smartphones for learning at home.	HA Classes A, B, & C	Science	-.213	0.050	85
I support the use of smartphones for learning everywhere.	LA Class H	English	-.423*	0.022	29
Using a smartphone at home is more helpful than going to the library.	LA Class H	English	-.431*	0.019	29
I can live without a smartphone.	HA Classes A, B, & C	Science	-.227	0.037	85
It is important that my child has access to a smartphone at home.	LA Class H	English	-.384*	0.040	29
It is important that my child as access to a smartphone at school.	LA Class H	Science	-.414*	0.040	25
My child uses the smartphone for help in completing his/her homework.	LA Class D	English	-.783*	0.022	8

(table continues)

Table 16 (*continued*).

Parent Survey Question	Group where achievement was observed	Class Subject	Pearson's *r*	*p*-value	*N*
My child should be taught how to use a smartphone as much as he/she is taught other subjects like Math or reading.	LA Class D	English	-.783*	0.022	8
It is important that my child learns how to use a smartphone so as to study and do his/her homework	LA Class D	English	-.783*	0.022	8
Knowing how to use a smartphone will help my child do well in school	LA Class D	Science	-.717*	0.045	8
I get involved in my child's education with the help of a smartphone.	LA Class H	English	.381*	0.042	29
	LA Class D	Science	-.735*	0.038	8

Note. *Correlation is significant at the 0.05 level (2-tailed). **Correlation is significant at the 0.01 level (2-tailed). Unless otherwise noted, survey response choices were: Strongly disagree/Disagree/Not sure/ Agree/Strongly agree. †Response choices were: AskNLearn, LMS, Surf the net, Take pictures, Others, Dictionary, Watch videos, MyCloud, SamEx, Homework, myDesk, Games, Chat/SMS, Limited Usage. HA = high achieving, LA = low achieving.

Summary of Research Question 2 Results

One observation that can be made using Table 16 suggests that LA parents have a strong positive view in terms of the construct of giving their children autonomy in using smartphones for learning, especially when the subject is science. While it is true that one of the LA correlations is negative for science, there are three that are positive. More than just being positive, the Pearson r coefficients are positive and close to one for several LA correlations. This observation means that there is greater strength in these LA relationships for the variables showing .879, .740, and .713 for science achievement and the statements listed versus the one negative relationship in the same construct, which was -.468 from LA Class H. The three statements for the high Pearson r coefficients just mentioned are:

- .879 – Class LA D – I am sensitive to many of my child's needs when he/she works on the smartphones.

- .740 – Class LA D – I allow my child to choose what to do with the smartphone whenever possible.

- .713 – Class LA D – I let my child decide what to do on the smartphone.

A second observation, which is related to the first one, is that the Pearson r coefficients of -.414, -.717, and -.735 for LA parents showed a highly negative correlation with their children's achievement in science within the construct of parental perception of the importance of smartphones. Two of those three coefficients are closer to -1 than the third one, meaning that the variables in those two relationships have a stronger connection than the variables in the other one. The statements for the two stronger correlations both relate to science achievement:

- -.717 – Class LA D – Knowing how to use a smartphone will help my child do well in school.

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- -.735 – Class LA D – I get involved in my child's education with the help of a smartphone.

A third observation is the presence of consistently negative correlations with English achievement across different constructs for parents in both LA groups. For example, of the ten correlations covering three constructs, only one is positive (.381), while the other nine are negative (-.783, -.783, -.783, -.468, -.383, -.423, -.474, -.431, -.384,). The construct for the one positive statement is parental perception of the importance of smartphones, and the statement is "I get involved in my child's education with the help of a smartphone."

The survey questions that resulted in statistically significant correlations are listed along with their construct categories.

ISP – Parental perception of importance of smartphones (5)

- -.431 – Using a smartphone at home is more helpful than going to the library.
- -.384 – It is important that my child has access to a smartphone at home.
- -.783 – My child uses the smartphone for help in completing his/her homework.
- -.783 – My child should be taught how to use a smartphone as much as he/she is taught other subjects like Math or reading.
- -.783 – It is important that my child learns how to use a smartphone so as to study and do his/her homework.

SPL – Parental support for the use of smartphones for learning (1)

-.423 – I support the use of smartphones for learning everywhere.

ASP – Parental support in giving child autonomy with smartphones (3)

- -.468 – I am usually willing to consider things from my child's point of view when he/she works on the smartphone.

- -.383 – I am sensitive to many of my child's needs when he/she works on the smartphones.

- -.474 – I am sensitive to many of my child's needs when he/she uses the smartphone.

A pattern can be seen in viewing these negative correlations next to the decreases in the English mean scores for the two LA classes ($M = 46.9$ to $M = 45.5$ for LA D, $M = 59.3$ to $M = 56.6$ for LA H).

Research Question 3

The third research question focuses on finding correlations between the students' and the parents' perspectives: Is there a relationship between students' and parents' positive beliefs about their children using technology for learning? These beliefs were provided through Likert-based responses on a parent survey given at the end of the school year.

Summary of Research Question 3 Results

One observation that can be made is that only one LA Class D student question had significant correlations with any of the parent statements, and all of them were positively correlated. The student question was "Do you have a smartphone?" In addition to being the only correlation with a student question, the relationships had very high p values of .747, .714, and .756 indicating that the strength of the relationship between the variables was higher than all other relationships for the other LA Class H, which had p values in the .200-.400 range.

A second observation that can be made is that of the six student survey questions that feature responses for LA Class H students having statistically significant correlations with parent survey statements, two of the questions had at least four correlations and all of them were positive. Those two LA Class H student questions were:

- Do you have a smartphone?

- Would you like to use a smartphone for your schoolwork?

Compare those four all positive correlations with the fact that there was only one other LA Class H student question with more correlations – five – but three of those were negative.

A third observation for this research question comes from the HA ABC classes in which there are 9 positive correlations, the highest number of correlations for any single student question in this class. Further, the question, "Do your parents approve of the use of smartphones for your schoolwork in your classroom?" had the highest number of correlations (5) under the parent survey construct of ISP — parental perception of the importance of smartphones. Those five ISP statements are:

- Using a smartphone at home is more helpful than going to the library.

- It is important that my child has access to a smartphone at home.

- It is important that my child learns how to use a smartphone so as to study and do his/her homework.

- Knowing how to use a smartphone will help my child do well in school.

- I get involved in my child's education with the help of a smartphone.

Statistical results for the correlations related to Research Question 3 are in Tables 17, 18, and 19.

Table 17

Research Question 3: All Data Results for Class D

Parent Survey Question	Student Survey Question
	Do you have a smartphone?
My child shows me his/her work on the smartphone (MC)	
Pearson's *r*	.747*
p-value	0.033
N	8
I ask my child to show me his/her work on the smartphone. (MC)	
Pearson's *r*	.714*
p-value	0.047
N	8
I get involved in my child's education with the help of a smartphone. (ISP)	
Pearson's *r*	.756*
p-value	0.030
N	8

Note. *Correlation is significant at the 0.05 level (2-tailed). ** Correlation is significant at the 0.01 level (2-tailed).

Table 18

Research Question 3: All Data Results for LA Class H

Parent Survey Questions	Student Survey Questions					
	Do you have a smartphone?	How many hours per week do you use apps or a web browser on your smartphone?	Would you like to use a smartphone for your schoolwork?	Does using a smartphone in the classroom help you learn?	Do your parents approve of the use of smartphones for your schoolwork in your classroom?	Would you like to have more mobile technology activities in your schoolwork?
I know what my child is doing on the smartphone. (MC)						
Pearson's *r*						-.465*
p-value						0.019
N						25
Please tick the 3 most common uses of the smartphone by your child at home. (UL)						
Surf the net						
Pearson's *r*						.423*
p-value						0.025
N						28
Watch Videos						
Pearson's *r*					-.431*	
p-value					0.022	
N					28	
I allow my child to choose what to do with the smartphone whenever possible. (ASP)						
Pearson's *r*	.486*					
p-value	0.009					
N	28					

(table continues)

Table 18 (*continued*).

Parent Survey Questions	Student Survey Questions					
	Do you have a smartphone?	How many hours per week do you use apps or a web browser on your smartphone?	Would you like to use a smartphone for your schoolwork?	Does using a smartphone in the classroom help you learn?	Do your parents approve of the use of smartphones for your schoolwork in your classroom?	Would you like to have more mobile technology activities in your schoolwork?
I let my child decide what to do on the smartphone. (ASP)						
Pearson's r	.444*					
p-value	0.018					
N	28					
I support the use of smartphones for learning during learning at home. (SPL)						
Pearson's r	.395*		.488**			
p-value	0.042		0.01			
N	27		27			
I support the use of smartphones for learning everywhere. (SPL)						
Pearson's r			.411*			
p-value			0.03			
N			28			
I am usually willing to consider things from my child's point of view when he/she uses the smartphone. (ASP)						
Pearson's r		-.401*	.544**			
p-value		0.034	0.003			
N		28	28			
I am sensitive to many of my child's needs when he/she uses the smartphone. (ASP)						
Pearson's r		-.426*	.417*			
p-value		0.024	0.027			
N		28	28			

(table continues)

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Table 18 (*continued*).

Parent Survey Questions	Student Survey Questions					
	Do you have a smartphone?	How many hours per week do you use apps or a web browser on your smartphone?	Would you like to use a smartphone for your schoolwork?	Does using a smartphone in the classroom help you learn?	Do your parents approve of the use of smartphones for your schoolwork in your classroom?	Would you like to have more mobile technology activities in your schoolwork?
It is important that my child has access to a smartphone at home. (ISP)						
Pearson's *r*	.424*					
p-value	0.025					
N	28					
It is important that my child has access to a smartphone at school. (ISP)						
Pearson's *r*					-.393*	
p-value					0.039	
N					28	
It is important that my child learns how to use a smartphone so as to study and do his/her homework. (ISP)						
Pearson's *r*						.469*
p-value						0.012
N						28
Parents should monitor their children's smartphone usage (MC)						
Pearson's *r*					.411*	
p-value					0.030	
N					28	
Parents should monitor their children's internet usage. (MC)						
Pearson's *r*				-.375*	.407*	
p-value				0.049	0.031	
N				28	28	

Note. LA = low achieving. *Correlation is significant at the 0.05 level (2-tailed). **Correlation is significant at the 0.01 level (2-tailed).

Table 19

Research Question 3: All Data Results for HA Classes ABC

	Student Survey Question				
Parent Survey Questions	Do you have a smartphone?	Would you like to use a smartphone for your schoolwork?	Does using a smartphone in the classroom help you learn?	Would you spend more time on your schoolwork if you used a smartphone to do the schoolwork?	Do your parents approve of the use of smartphones for your schoolwork in your classroom?
My child enjoys learning using his/her smartphone. (CL)					
Pearson's *r*		.266*	.310**	.331**	
p-value		0.02	0.006	0.003	
N		76	76	76	
My child shows me his/her work on the smartphone (MC)					
Pearson's *r*	-.232*				
p-value	0.043				
N	76				
I ask my child to show me his/her work on the smartphone. (MC)					
Pearson's *r*				.258*	
p-value				0.024	
N				76	
I let my child plan what to do on the smartphone. (ASP)					
Pearson's *r*					.313**
p-value					0.006
N					76
I let my child decide what to do on the smartphone. (ASP)					
Pearson's *r*					.268*
p-value					0.02
N					75

(table continues)

Table 19 *(continued).*

	Student Survey Question				
Parent Survey Questions	Do you have a smartphone?	Would you like to use a smartphone for your schoolwork?	Does using a smartphone in the classroom help you learn?	Would you spend more time on your schoolwork if you used a smartphone to do the schoolwork?	Do your parents approve of the use of smartphones for your schoolwork in your classroom?
I support the use of smartphones for learning in school. (SPL)					
Pearson's *r*				-.237*	.243*
p-value				0.039	0.035
N				76	76
I support the use of smartphones for learning at home. (SPL)				.	
Pearson's *r*					.338**
p-value					0.003
N					76
I support the use of smartphones for learning everywhere. (SPL)					
Pearson's *r*					.430**
p-value					0
N					76
All pupils in the school should use smartphones for learning. (SPL)					
Pearson's *r*					.358**
p-value					0.002
N					76
Using a smartphone at home is more helpful than going to the library. (ISP)					
Pearson's *r*	-.313**				.321**
p-value	0.006				0.005
N	76				76

(Table continues)

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Table 19 *(continued)*.

	Student Survey Question				
Parent Survey Questions	Do you have a smartphone?	Would you like to use a smartphone for your schoolwork?	Does using a smartphone in the classroom help you learn?	Would you spend more time on your schoolwork if you used a smartphone to do the schoolwork?	Do your parents approve of the use of smartphones for your schoolwork in your classroom?
It is important that my child has access to a smartphone at home. (ISP)					
Pearson's *r*					.364**
p-value					0.001
N					76
My child uses the smartphone for help in completing his/her homework. (ISP)					
Pearson's *r*				.246*	
p-value				0.032	
N				76	
It is important that my child learns how to use a smartphone so as to study and do his/her homework. (ISP)					
Pearson's *r*					.342**
p-value					0.002
N					76
Knowing how to use a smartphone will help my child do well in school. (ISP)					
Pearson's *r*					.333**
p-value					0.003
N					76

(table continues)

Table 19 (*continued*).

Parent Survey Questions	Student Survey Question				
	Do you have a smartphone?	Would you like to use a smartphone for your schoolwork?	Does using a smartphone in the classroom help you learn?	Would you spend more time on your schoolwork if you used a smartphone to do the schoolwork?	Do your parents approve of the use of smartphones for your schoolwork in your classroom?
I get involved in my child's education with the help of a smartphone. (ISP)					
Pearson's *r*					.359**
p-value					.001
N					76

Note. HA = low achieving. *Correlation is significant at the 0.05 level (2-tailed). ** Correlation is significant at the 0.01 level (2-tailed).

Summary

While the data from this study provide opportunities to make many interesting observations, nine were selected because they were closely related to the concepts discussed in the literature review. Three observations came from each research question. The observations were also chosen because they represented different ways to view the analyses, such as looking at the strength of the relationship of the variables, the number of positive correlations, and the comparison of correlations between LA and HA parents and students. The possible meanings of those correlations will be discussed in the next chapter.

CHAPTER 5

DISCUSSION

This chapter will discuss the study's results, which show that statistically

significant relationships exist between students' and parents' positive perceptions about

using smartphones for learning and an increase in achievement. More specifically

regarding the impact on LA students, the results show that the key topics coming from

this study are:

1. The subject of science versus English was perceived more positively by

    students and parents, which correlated with an increase in science

    achievement scores.

2. Learning-related activities being completed on mobile devices seemed to be

    one of the most appealing ways for LA students to build knowledge that was

    correlated with an increase in science achievement.

3. LA parental support with some kind of direct interaction with the child

    appeared to be appreciated by students and was positively correlated with an

    increase in science achievement.

Those three observations are supported by six other observations made in this

study. Those analyses will be explained in this chapter. In order to put those

observations in the proper context, it is important to review the three research questions

that led to those findings. The questions are:

1. Is there a relationship between students' positive beliefs about using

    smartphones for learning and their increased achievement scores?

2. Is there a relationship between students' positive beliefs about using smartphones for learning and their increased achievement scores?

3. Is there a relationship between students' and parents' positive perceptions about using smartphones for learning?

In all there were nine observations made in this study. Those observations tie together the concepts of primary teaching at a school in Singapore, 21st century critical thinking, mobile learning, inquiry-based learning, seamless learning, self-directed learning, parental involvement, and achievement scores. The main point that comes from this study is that for two groups of third-grade LA students at a Singapore primary school, a positive correlation exists between an increase in science achievement on one hand and a motivation to investigate scientific questions by completing activities on smartphones and by receiving parental support on the other hand.

Research Question 1

The answer to the first research question is yes; a relationship exists between a student's positive attitude about using smartphones for learning and an increase in achievement. The relationship that is the focus of this study is with LA students as opposed to HA students, and the increase in achievement came mostly in science versus English. The three observations that were made about the findings for this research question are:

- In terms of an increase in science achievement, the strength of the correlations is almost double for LA students compared to the science achievement correlations for HA students.

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- The two LA correlations in science and an increase in science focus on the activity aspect of using a smartphone for learning, while the single LA correlation with English was based on liking the subject.

- The LA student focus on completing learning activities on the smartphones is present in both of the LA groups' correlations in science, which also mirrors the results from the HA classes in the same subject.

These three observations will be discussed in terms of how they relate to the supporting topics discussed in the literature review and how they could lead to the development of new mobile learning strategies with the improvement of LA student achievement as the primary goal.

Observation 1: Strength of Correlations

The questions and the coefficients of the correlations for the two LA student classes D and H are as follows:

- LA Class D – Would you like to have more mobile technology activities in your homework? (science achievement coefficient = .403)

- LA Class H – Would you like to use a smartphone for your schoolwork? (science achievement coefficient = .463)

The questions and the coefficients of the correlations of the HA Classes ABC two correlations are as follows:

- Would you spend more time on your schoolwork if you used a smartphone to do the schoolwork? (science achievement coefficient = .259)

- Would you like to have more mobile technology activities in your homework? (science achievement coefficient = .240)

The first point to note is that the LA coefficients (.403 and .463) are almost twice as much as the HA coefficients (.259 and .240). The higher number for the LA correlations means that the LA variables have stronger relationships than the HA variables. This point could mean that LA students might have a greater motivation to complete science-related studies than HA students.

Another point from these results is that the introduction of the smartphones into the science classroom could indicate a new pathway to increase achievement scores for LA students. In addition, the LA students could be on the same path to processing knowledge in science classes with the use of smartphones as the HA students are already using for their increase in achievement scores.

Observation 2: LA Focus on Activity

The second observation is that the LA students in Classes D and H respectively appear to view activity more in terms of the engagement aspect with the increases in science for both classes and Class D students' responses to the survey question "Would you like to have more mobile technology activities in your schoolwork?" and the responses to the question "Would you like to use a smartphone for your schoolwork?" for students in Class H. These correlations do not refer to valuing time or an academic process; instead, they point toward the action aspect of engaging with the content. It appears that LA students appreciate the opportunities to communicate with fellow students, teachers, and parents, along with the ability to create artifacts with a mobile device's features and apps. This appreciation to do those activities combined with the correlation of an increase in science achievement might indicate a recipe that instructional designers should follow when building mobile learning classes.

Observation 3: LA and HA Focus on Activity

Continuing on the concept of finding a commonality in how LA and HA students process information in science classes, the third observation is the idea of doing activities on the smartphone must be explored. For example, one point of common ground between the HA group and LA Class D came from the correlations dealing with an increase in science achievement and the question "Would you like to have more mobile technology activities in your schoolwork?" Both the HA group and the LA Class D showed a positive correlation. These results might demonstrate the concept of a preference for activity, which seems to cut across achievement backgrounds.

It is also possible that these two student groups gravitate toward activity with the smartphone and an increase in achievement for different reasons. For instance, the HA group might be focusing on a more efficient way to follow the steps of the scientific method that is afforded with the communication and organizational apps and features of the smartphone, compared to the traditional ways of writing and maintaining notes with paper and pencil. Conversely, the LA students in Class D could be viewing the scientific activities in a similar manner to how they engage with online games.

In addition, another way to view the focus on activities between the HA and LA groups could potentially come from their respective views of the value of time. For instance, the HA group seems to value time in order to complete science-related activities. This observation is based on the two HA student correlations, both with an increase in science achievement, from the questions (a) "Would you spend more time on your schoolwork if you used a smartphone to do the schoolwork?" and (b) "Would you like to have more mobile technology activities in your schoolwork?" Those two

examples could be seen as the students wanting to make the best use of their time for academic work.

Research Question 2

The answer to the second research question is yes; the study results showed that relationships exist between an increase in achievement and with the notion that parents have positive attitudes towards using smartphones for learning. These relationships are especially clear when viewed in terms of three observations that came from this research project:

- LA parents have a strong positive correlation between science achievement and the autonomy construct.

- LA parents have a negative correlation between science achievement and the parental perception of importance of smartphones construct.

- LA parents have negative correlations between English achievement and various constructs.

Those three observations will now be discussed in detail.

Observation 4: Autonomy Construct

The fourth observation that can be made indicates that LA parents have a robust positive view in terms of the construct of giving their children autonomy in using smartphones for learning science. The parents might like the fact that students can research questions that the parents cannot answer, which takes away pressure from the parents to have to know everything. As a result, the parents might end up feeling more inclined to see their children get those answers, which is why the construct of autonomy could be playing a big role here.

Observation 5: Smartphone Importance Construct

It is interesting to note that within the construct of parental perception of the importance of smartphones, the three Pearson *r* coefficients of the following for LA parents were very negatively correlated with their children's achievement in science:

- -.414 – Class H – It is important that my child has access to a smartphone at school.

- -.717 – Class D – Knowing how to use a smartphone will help my child do well in school.

- -.735 – Class D – I get involved in my child's education with the help of a smartphone.

These results could be indicating that parents see smartphones as being very important, and as a result possibly not looking at their children's homework as in depth as they might have if the mobile devices were not present. Also, it is possible to tie these results with the previous observation in which the parents gave their children great autonomy to use the smartphones for learning. This lack of in-depth involvement because of a reliance on a student's autonomy in using the smartphone for learning could be a reason for the negative correlation.

The smartphone is just like any tool. Certainly, tools are used because they accomplish goals that were previously difficult or impossible to do. However, the introduction of that tool could be viewed as the reason why other skills have diminished. For example, it is widely accepted that when spoken language was translated into printed form and then the printing press arrived, people began to rely more on writing their ideas and less on memorizing poems, speeches, and stories.

Observation 6: English Achievement

The negative correlations in English achievement and a variety of constructs for LA parent statements might indicate that the parents have a difficult time helping with the subject. For instance, only one of the eight correlations is positive (.381). That positive statement "I get involved in my child's education with the help of a smartphone" falls under the construct of parental perception of the importance of smartphones. However, the other seven LA parent statements are all negative and come under the following constructs:

- ISP – Parental perception of importance of smartphones
  - -.783 – My child uses the smartphone for help in completing his / her homework.
  - -.783 – My child should be taught how to use a smartphone as much as he/she is taught other subjects like Math or reading.
  - -.783 – It is important that my child learns how to use a smartphone so as to study and do his/her homework.
  - -.431 – Using a smartphone at home is more helpful than going to the library.
  - -.384 – It is important that my child has access to a smartphone at home.
- ASP – Parental support in giving child autonomy with smartphones

  -.474 – I am sensitive to many of my child's needs when he/she uses the smartphones.
- SPL – Parental support for the use of smartphones for learning

  -.423 – I support the use of smartphones for learning everywhere.

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This list shows that the highest number of statements, five, come from the ISP construct. This finding might indicate that these LA parents have some kind of difficulty in showing that they believe in the importance of smartphones for learning because of the inverse relationship between their views and achievement scores.

Research Question 3

The answer to the third research question is yes; the study results showed that relationships exist between the positive attitudes of students and parents towards using smartphones for learning. These relationships are especially clear when viewed in terms of three observations that came from this research project:

- LA Class D students had one question with positive correlations – "Do you have a smartphone?"

- LA Class H parents had four statements with a positive correlation with this student question about having a smartphone.

- Parental approval seemed to be important for HA Class ABC students and parents.

Those three observations will now be discussed in detail.

Observation 7: Having a Smartphone

The seventh observation that can be made is that the only three correlations that existed for LA Class D students and parents related to the student question "Do you have a smartphone?" and three different parent statements. The fact that there were no negative correlations and that the three correlations were all above .7 means that these variables are strongly related to each other and something interesting is happening. That interesting occurrence could be that these LA students and parents come together

in a critical way for learning to happen, meaning that the students see the value of having a smartphone while the parents want to be involved in their children's studies and take the action to see the work being done. This finding shows a new dialogue taking place between LA students and parents that up until this point might either not have existed or at least not as productive a form as this one. As a result, both the LA Class D students and parents are engaging in a conversation that is a key step in the deep learning process that will lead to developing 21st century critical thinking skills.

Observation 8: Using Smartphones for School Work

In addition to LA Class H students having at least three positive correlations with the question about having a smartphone, these students also had positive correlations with the question related to using a smartphone for schoolwork. The parent statements that correlated with this question were based on supporting the use of smartphones for doing schoolwork, along with being sensitive to the child's needs and considering the child's perspectives when he/she is working on the smartphone for school. These results directly support the findings from the LA Class D students and parents through the focus on support and sensitivity on the parents' part to ensure that the learning process grows and develops.

In other words, if the parents did not see value in the student having a smartphone for learning, then a positive correlation with the concepts of support and sensitivity would not likely exist. Therefore, the evidence of a productive dialogue happening between LA students and parents appears to be unfolding, which is based on the presence of the smartphone as the mediator of learning experiences that begin in school and continue at home.

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Observation 9: Parental Approval

The ninth and final observation that can be made relates to the parental approval as indicated by HA Classes ABC students and the positive correlations with various parent statements. The fact that these correlations exist is important because it could indicate that there is a similarity with what the LA students are experiencing. The part that is similar with the LA students is the existence of a dialogue with parents. The dialogue on the part of the LA students relates to having a smartphone and having the support in different ways from the parents. For the HA students, the approval of the parents is also combined with the statements of supporting the use of smartphones for learning in school, at home, and everywhere. In addition, the existence of five positive correlations coming under the parent construct of perceiving the importance of smartphones reinforces this concept of the parent ensuring that the child has the requisite tool, the smartphone, to complete his/her school work. This finding seems to reinforce the notion that a dialogue exists in the relationship of HA students and HA parents in the same way that a similar productive dialogue now exists for LA students and parents. These conversations are all based on the introduction of the smartphone as the primary learning tool.

Future Research

More research should be completed to understand in greater depth the meaning of these nine observations. For instance, the written comments from students and parents should be investigated to see how they match up with these findings. Another direction could be to analyze the differences between the two LA classes in terms of English and science achievement scores throughout the year. In addition, looking at

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potential differences related to teachers of the respective classes and how those instructors might have influenced achievement and attitudes towards using smartphones for learning might reveal interesting perspectives. Below are ten specific directions for future research:

- Conduct a semistructured interview with students to understand their motivations for completing the mobile learning activities.

- Investigate whether collaborative or individual mobile activities in science improve student achievement.

- Determine if HA students and LA students use the same metacognitive steps in completing activities that lead to increased achievement in science.

- Add a question to the semistructured interviews with parents to understand their motivations in providing autonomy to their children who use smartphones for learning.

- Lead semistructured interviews to understand why the parents do not see the importance of smartphones for learning.

- Research whether the educational background of parents impact the increase in English achievement.

- Include a question in the semistructured interviews that asks the LA parents why they believe it is important for their students to have smartphones.

- Find out from LA students and parents why having a smartphone and parental support are important.

- Focus on HA students and parents to understand why parental approval is important to them.

- Use a psychometric scale for analysis instead of analyzing correlations.

Limitations

One of the limitations of this study was the fact that I did not have the opportunity to visit the school, the students, or the parents. Not having this direct connection with the people and the environment made me rely solely on the spreadsheet data and conversations with Dr. Norris, Dr. Soloway, and Dr. Knezek. While those conversations were extremely helpful in providing me with a more complete context of the environment in which the data were collected, not having first-hand knowledge of the setting prevented me from having a fuller perspective on what the numbers meant.

Another limitation of the study was the low number of responses from the parents of LA Class D. The data were set up so that a child's responses were matched with the responses of her/his parent. Having only eight responses from LA Class D parents in this quantitative study could lead to questions about how to interpret that data because of the small number of respondents.

A further limitation was the fact that there was not a 1:1 comparison between LA and HA students and parents. I made the decision to use both LA classes separately and the three HA classes as one group based on statistical analyses. However, the ideal circumstance would have been to compare one LA class with one HA class.

Conclusion

This study showed that there is a new kind of dialogue between LA students and parents that centers on the use of the smartphone for learning. There were nine observations made based on the three research questions. These observations indicated that while there are differences between the students' and parents' positive

attitudes about using mobile devices for learning, there are similarities as well. It is

these similarities that are the most interesting part of this research because if the links

can be identified in what LA students and parents are doing that is similar to those of

HA students and parents, then new insights into designing mobile learning courses and

curricula can be implemented to improve the achievement of LA students.

APPENDIX A

STUDENT SURVEY

Appendix A

Student Survey

Survey administered by a Singaporean Primary School.
Survey administered Term 1 of 2015.

When an idea is shared in class, I try to decide if there is a good reason for that idea.

I often question things I hear or read to decide if they are true.

I come up with my own ideas on things I have learnt in school.

I try to think of other ideas related to what I learn in school.

It's important to me that other students in my class think I am good at my class work.

One of my goals is to show others that class work is easy for me.

One of my goals is to look smart in comparison to the other students in my class.

It's important to me that I look smart compared to others in my class.

My parents let me make my own plans.

My parents allow me to choose what to do whenever possible.

My parents let me decide things for myself.

I have a great deal of control over my results in school.

No matter what I do, I can't seem to do well in school.

I see myself as largely responsible for my performance in school.

There is little I can do about my performance in school.

My results are basically decided by things out of my control and there is little I can do to change that.

It's important to me that I learn a lot of new things this year.

It's important to me that I fully understand my class work.

It's important to me that I improve my skills (e.g. how to answer a comprehension question, how to tell a story) this year.

APPENDIX B

PARENT SURVEY

Appendix B

Parent Survey

Survey administered by a Singaporean Primary School.
Survey administered Term 1 of 2015.

| Your child has received a smartphone for learning this year. Please share your thoughts on the following statements by ticking the appropriate boxes.

Unless otherwise specified, answer responses are: Strongly Disagree, Disagree, Neutral, Agree, Strongly Agree |

My child enjoys learning using his/her smartphone.

My child shows me his/her work on the smartphone.

I ask my child to show me his/her work on the smartphone.

I know what my child is doing on the smartphone.

My child likes to use the smartphone.

Please tick the 3 most common uses of the smartphone by your child at home:

    ☐ AskNLearn LMS
    ☐ Surf the net
    ☐ Take pictures
    ☐ Dictionary
    ☐ Watch videos
    ☐ Others. Please specify: _____

My child spends enough time on the smartphone for learning.

Please indicate the amount of time you allow your child to use the smartphone at home per day.

    ☐ Less than 1 h
    ☐ More than 1 h - less than 2 h
    ☐ More than 2 h - less than 3 h
    ☐ More than 3 h - less than 4 h
    ☐ More than 4 h - less than 5
    ☐ More than 5
    ☐ Others. Please specify: _____

I listen to my child's opinions when he/she works on the smartphone.

I let my child plan what to do on the smartphone.

I am usually willing to consider things from my child's point of view when he/she works on the smartphone.

Appendix B *(continued)*.

I am sensitive to many of my child's needs when he/she works on the smartphones.

I allow my child to choose what to do with the smartphone whenever possible.

I let my child decide what to do on the smartphone.

I insist upon my way when my child works on the smartphone.

I set rules for the use of the smartphone at home.

I set rules for the use of the internet at home. Please indicate the rules which you have set, if applicable.

I support the use of smartphones for learning in school.

I support the use of smartphones for learning during learning journeys/excursions.

I support the use of smartphones for learning at home.

I support the use of smartphones for learning everywhere.

All pupils in the school should use smartphones for learning. Please explain.

If I don't know how to use a smartphone, I would like to learn.

Smartphones are important learning tools.

Those who have successful jobs know how to use the smartphone.

Using a smartphone at home is more helpful than going to the library.

I can live without a smartphone.

It is important that my child has access to a smartphone at home.

It is important that my child has access to a smartphone at school.

My child uses the smartphone for help in completing his/her homework.

My child should be taught how to use a smartphone as much as he/she is taught other subjects like Math or reading.

It is important that my child learns how to use a smartphone so as to study and do his/her homework.

Knowing how to use a smartphone will help my child do well in school.

I get involved in my child's education with the help of a smartphone.

Parents should monitor their children's smartphone usage.

Parents should monitor their children's internet usage.

My child will need to know how to use a smartphone to be successful in life.

Any other comments

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