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Emerging Research Interests that Complicate Data Analysis: How the Past Informs the Present

Donna E. Alvermann, Ph.D.
Helene Halstead, Ed.S.
Marie Troutman Goodwin, M.A.
Lloyd P. Rieber, Ph.D.

The University of Georgia

Abstract

Increased interest in researching students' online literacy learning in the United States, particularly in the area of written argumentation, continues to attract external funding by both federal and private organizations. The authors of this article were fortunate to have received a grant from The Bill & Melinda Gates Foundation that required working with students in grades four through eight to develop an online learning tool that targeted three Common Core State Standards involved in written argumentation. Complications arose when the funding cycle did not align with the local school calendar. A series of events led to the researchers having to limit their data analysis to computer-generated records. This article describes how the researchers used two theoretical frames that differed not only in historical time but also in underlying assumptions to arrive at an analysis that satisfied the funding agency and their institution's human subjects review board.

By fourth grade, students in high-need schools lag considerably behind their peers from more economically advantaged backgrounds, and the gap widens as they move through middle school. This discrepancy is particularly visible in the area of persuasive writing that Common Core State Standards (CCSS) expect students to master (http://www.corestandards.org). No matter how controversial the CCSS are in some states, mastery of written argumentation has been a mainstay in U.S. schools for decades, and these standards show no signs of abating in a Web-based world that depends on media of one kind or another to transmit ideas and opinions for which little or no evidence sometimes exists.

Another mainstay in U.S. educational debates is the tension that has existed since the early 20th century over the locus of control when it comes to teaching students of all ages how to read and write in the core disciplines (science, mathematics, social studies, and the English language arts) (Alvermann & Moje, 2013). From the time of William S. Gray (1925) to the more recent Common Core State Standards, the call has been for every teacher, regardless of disciplinary training, to instruct students in reading and writing skills, such as written argumentation. Though seemingly logical, a majority of secondary teachers have historically viewed this call as an unfair demand on their time given their lack of expertise in literacy instruction (Dillon, O'Brien, Sato, & Kelly, 2011). In turn, this situation has led to a longstanding tension between literacy education and science education researchers (Holliday, Yore, & Alvermann, 1994). It is a tension we argued in our proposal to The Bill & Melinda Gates Foundation that we could address effectively by developing the online role-playing tool PersuadeMe.

PersuadeMe is based on the simple premise that all people have opinions on

issues that matter to them. Just as many adults are eager to share their opinions about whether or not they think climate change is a real phenomenon that human activity directly influences, fourth grade students will likely be just as happy to discuss at length which lunches served at their school are or are not their favorites. However, when students are sked to give reasons for theiropinions, the resulting conversations yield different sorts of responses. These conversations often reveal a disposition for one belief over another with claims based on evidence that usually contain bias in favor of those dispositions. Pushing someone to support their claims with evidence and responding to contradicting evidence is a challenge.

PersuadeMe is also based on the premise that people enjoy sharing their opinions with others. Doing so is an inherently social activity. Even if one holds an opinion in secret, the motivation not to share is likewise a social one. We might be afraid if our opinion is not shared by those we respect (or fear). Having the opportunity to share our opinions with others honestly in a safe anonymous environment, particularly one that rewards support and collaboration while promoting reflection and review of the opinions we hold and why, is what we believe makes PersuadeMe such a powerful learning environment.

PersuadeMe

A PersuadeMe experience is organized around the idea of a tournament. Each tournament begins with the identification of a topic, followed by dividing the participating students into two groups: 1) idea innovators; and 2) idea investors. The idea innovators write persuasive arguments on the topic of the tournament. The idea investors read and critique the arguments as well as invest in arguments as a vote of confidence.

Each PersuadeMe Tournament involves a number of rounds, usually about three. Each round is divided into two parts.

The first part focuses on the innovators writing their arguments and rationales. At this point, they are not yet asked to provide specific evidence. This is done based on the belief that it enhances engagement by allowing the students to quickly “take a stand” on the issue stemming from their prior knowledge and feelings. The second part of the round is when the investors review the innovators’ arguments and rationales. As investors read the arguments, they can vote to "invest in an argument" by giving it a positive vote—measured in as many idea dollars as they wish to spend—which increases the value of an argument within the role-playing community. Investors are also encouraged to offer suggestions to innovators whose arguments are not found to be persuasive in order to improve the argument. All arguments, critiques, and investments are completed anonymously; students do not know each other’s identity or roles in a tournament. This practicehelps preserve fairness by reducing the chance of popularity bias among students. It also helps to limit a student’s emotional exposure should a particular argument or evidence not be received well in any single round.

In round two, innovators are required to include evidence to support their positions and are given time and guidelines for doing so. They are also expected to update their arguments at the beginning of the round in light of the evidence they have found. It is therefore conceivable for an innovator to completely change his or her opinion as a tournament unfolds. Investors return to the argument to critique supporting details and vote with their idea dollars.

It's important to note that the results of a single round are not immediately published for the entire group to see. Instead, the idea innovators are provided their individual results in private along with any feedback that investors chose to give them. This gives all idea innovators the opportunity to revise and strengthen their arguments based on earlier feedback before the next round begins. At a time to be determined by the teacher, the next round begins at which point all of the results of the previous round are published to all participants. The idea investors proceed to invest in the idea innovators' persuasive arguments based on the revisions. In this way, previously weak arguments that are now strengthened have the opportunity to garner more support by the investors. After each round of a tournament, the "voting via investing" moves the most persuasive student arguments up in importance or value. Students who wrote weaker arguments in a preceding round begin each subsequent round with the advantage of sufficient feedback from both peers and teachers. PersuadeMe's game-like strategy ensures that winners are ultimately determined by the value of their arguments and supporting details (or evidence) at the end of a tournament.

The research basis for PersuadeMe comes from a long line of studies in late 20th century that focused on student cognition, motivation, and sociocultural learning. For example, research reviewed by Guthrie and Wigfield (2000) in support of their engagement model for literacy teaching and learning showed that cognitive tasks such as written argumentation are mediated by a student's motivation to complete those tasks. PersuadeMe is a learning tool that resembles a game, thereby engaging student motivation to participate. Likewise, Graham and Hebert's (2011) meta-analysis of the impact of writing and writing instruction on reading achievement, and Duschl and

Osborne's (2002) review of the literature on argumentation supports PersuadeMe's goal of engaging students in cognitive, social, and collaborative processes that are known to nurture and sustain motivation for mastering higher order thinking skills. Finally, Toulmin's approach to argumentation, on which PersuadeMe rests, has garnered research support for over a decade, especially in relation to its use in science classroom instruction (Erduran, Simon, & Osborne, 2004).

Theoretical Perspectives and Challenges

Two theoretical perspectives were used in the analysis of the PersuadeMe prototype and the internal data generated from a pilot study. One perspective was derived from Bourdieu's (1977) approach to studying humans as they socially interact. A second perspective, referred to as New Materialism (Bennett, 2009), focused primarily on non-human actants. Both of these theories were used under the IRB constraints that restricted analysis to the non-human prototype.

Perspectives

Bourdieu and Passeron's (1977) pivotal text *Reproduction in Education, Society and Culture* was published almost forty years ago. Despite its prominence in the field of sociology and the incorporation of technological tools, such as PersuadeMe, into educational settings, social theory has remained largely a canonical theory (Blommaert, 2015). Notwithstanding this limitation, we opted to use Bourdieu's social theory to assess potential instructional advantages for the tool PersuadeMe. Specifically, we were interested in how one's habitus—that is, one's socially reproduced attitudes and values at a given time and place (Sullivan, 2002)—would be reflected in playing the online game PersuadeMe.

By investigating the in-game, raw-data discourse and how it differs from in-class discourse, we hoped to better understand a player's allocation of virtual funds in successive rounds and tournaments. Because social theory indicates that a person's values are not only constructed within a single community, but also reconstructed in other communities in which that person engages, it was important to ensure that our data analysis focused on the in-game habitus of PersuadeMe rather than on the classroom per se.

From a New Materialism perspective, Jane Bennett's (2009) *Vibrant Matter* emphasizes the agency of non-human actants. In analyzing PersuadeMe from this perspective, the analysis examined the "enablements" of the prototype, meaning the activity that was elicited by the prototype. This analysis focuses on non-human actants, in keeping with the new materialist perspective and the IRB restrictions that applied to this research. Four non-human components of a PersuadeMe tournament were particularly salient: PersuadeMe itself, the computer assemblage, the prompt, and the suggestions. All of these actants are themselves assemblages of multiple moving parts. These assemblages consist of many components, both human and non-human. In order to illustrate what is meant by non-human actants, here are some of the salient components of each assemblage.

- PersuadeMe is the online prototype, consisting of its visual appearance, structure [including the boxes for entering arguments, rationale, and evidence], rounds of argumentation, and financial incentive.
- The computer assemblage is the computer, Internet connection, screen, mouse, and keyboard.

- The prompt is the question posed for debate, as well as issues and topics related to the question that may have resonated in a given argument.
- The suggestions are the comments and ideas that the prototype evoked as a means of improving the original argumentation presented.

Examining these assemblages individually and in conjunction provided the information we needed in order to determine what activity the prototype was able to elicit.

Challenges

Although different perspectives were used in the examination of PersuadeMe, the two analysts faced similar challenges. The primary challenge resulted from the researchers being restricted to analyzing a non-human prototype (PersuadeMe) as a result of receiving notification of funding from The Bill & Melinda Gates Foundation too late in the academic year to obtain their institutional review board's approval to collect data on the students who actually played the online game. While raw data collected by PersuadeMe's internally generated evaluation system provided information on the object's game-playing elements, it did not allow us to examine the players' social interactions while engaging with the various rounds of game-play.

The restriction to non-human actants did not pose a significant challenge to a new materialist analysis; indeed a new materialist perspective makes a similar requirement of the researcher. In this perspective, analysis must take into account the non-human components of the phenomenon under investigation (although it would not necessarily rule out any analysis of the human elements, as was the case here). The primary challenge in a new materialist analysis was the gaps in information regarding specific physical characteristics of the non-human actants. For instance, further data regarding

the look and feel of the prototype, as well as the way it was designed for use, would potentially provide an even richer analysis.

This restriction did, however, pose a challenge to the use of a social theory perspective. This framework examines exchanges of cultural, social and economic capital as a reflection of the human actants' habitus. The additional data from observing an authentic setting of the game in use would have allowed for an interpretation of the impetus for certain arguments, responses, and distribution of PersuadeMe funds.

Methodology

To adhere strictly to the two theoretical perspectives just named, we needed to analyze data on both human and non-human actants. Such an assemblage, while ideal, was impossible given the constraints of having insufficient time for a full human subjects review; thus, we limited our data collection methods and analysis to include only the non-human actants. This arrangement presented no difficulty in terms of data collection; we simply focused our attention on the evaluation aspects of the prototype. That is, we coded each response elicited by the online prototype for each of the three tournaments. Each tournament was designed for a different written argumentation topic (e.g., cell phones in schools, school dress uniforms, and video games). Restricted to studying a non-human actant, we relied on Jackson and Mazzei's (2012) rationale for plugging in a common data set across the two theoretical perspectives that informed our study.

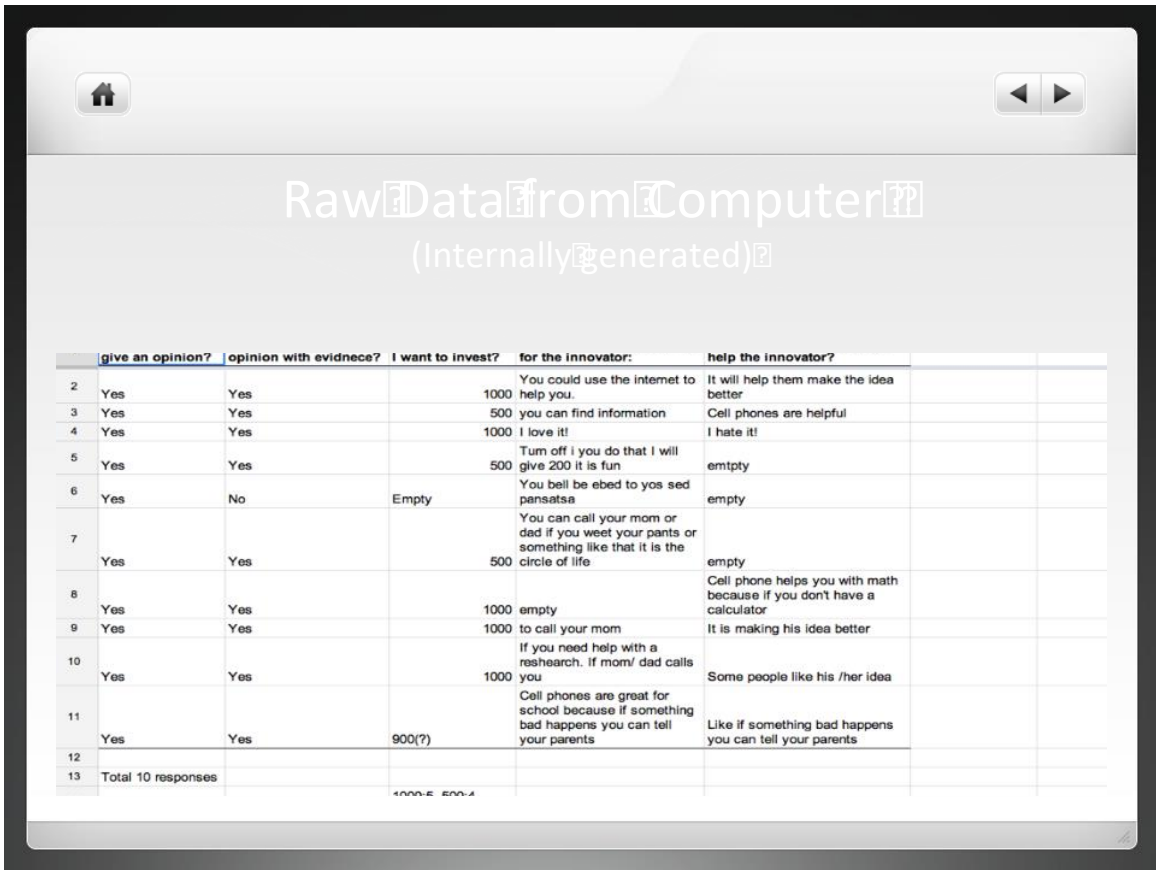
Data Sources

The primary data source was the password-protected website that housed the evaluation functions of PersuadeMe. A secondary data source included the results from the rounds of tournament play.

Analytic Procedures

To conduct an analysis of PersuadeMe from a social theory perspective, it was necessary to first determine which aspects of the tool-generated data reflected social, economic, and cultural capital. The next step was to determine how the exchanges of those capitals reflected and constructed the in-game habitus. The New Materialist lens defined its primary components of analysis differently. This perspective provided a more direct examination of the non-human actants that comprised the tool itself, as discussed previously.

Findings



	give an opinion?	opinion with evidnece?	I want to invest?	for the innovator:	help the innovator?
2	Yes	Yes	1000	You could use the internet to help you.	It will help them make the idea better
3	Yes	Yes	500	you can find information	Cell phones are helpful
4	Yes	Yes	1000	I love it!	I hate it!
5	Yes	Yes	500	Turn off i you do that I will give 200 it is fun	emtpty
6	Yes	No	Empty	You bell be ebed to yos sed pansatsa	empty
7	Yes	Yes	500	You can call your mom or dad if you weet your pants or something like that it is the circle of life	empty
8	Yes	Yes	1000	empty	Cell phone helps you with math because if you don't have a calculator
9	Yes	Yes	1000	to call your mom	It is making his idea better
10	Yes	Yes	1000	If you need help with a reshearch. If mom/ dad calls you	Some people like his /her idea
11	Yes	Yes	900(?)	Cell phones are great for school because if something bad happens you can tell your parents	Like if something bad happens you can tell your parents
12					
13	Total 10 responses				

Figure 1. Data collected from PersuadeMe shows the feedback provided by peers to one student's argument. The figure demonstrates that this particular round of argumentation

enabled discussion and suggestions. Many of the suggestions provided reasons that cell phones are good in class, countering the original argument presented. The computer assemblage also enabled the addition of emphasis through exclamation marks in one suggestion.

The tool was designed to foster the engagement of students in cognitive, social, and collaborative processes. This engagement would, in turn, sustain motivation so that students can work toward a mastery of skills such as written argumentation. Both perspectives were able to provide analysis of the tool and how this engagement might occur.

From a social theory perspective, the tool PersuadeMe appeared to support collaboration in terms of co-constructed arguments motivated by pre-determined prompts. The substantial number of written exchanges between an innovator and an investor led us to assume that the tool was engaging. However, absent from the accumulated data were indicators that would have further strengthened our assumption concerning collaboration. For instance, we found neither an overwhelming acceptance of investors' suggestions, nor for that matter a tendency on the part of investors to offer much in the way of helpful critiques that potentially could have increased a range in distributions of economic capital. Based on the rarity with which investors' suggestions were taken into account by the innovators, one is left to wonder if the in-game habitus was at odds with the in-class habitus.

What can also be seen is that written exchanges in the form of collaboration may be based on a variety of reasons; we cannot determine from the data pool why players

ignored suggestions or even used specific language in their arguments. As mentioned earlier, a social theory perspective examines *why* in relation to *what.*

In reference to Figure 1, line 7 shows that an investment was made in the amount of $500.00. This is an exchange of economic capital, but we cannot be sure why the exchange was made. If this investment was generated because "if you weet (sic) your pants or something like that it is the circle of life" is a sound argument to the prompt asking if students should have cell phones in school, then cultural capital was in use and the values of the class may be reflected. If, however, the $500 was allocated in response to potty humor, then a reflection of in-game habitus would be a reasonable assumption. Because of this ambiguity and our inability to use interview data (per our human subjects review board), we cannot say with certainty whether or not PersuadeMe enabled the exchange of capitals.

We found that argumentation was frequently strongest in Round 1 and tapered off in later rounds. Closer observations of PersuadeMe tournaments in future research when restrictions on data analysis do not apply would yield a better understanding of the factors that may have led to decreased use of argumentation skills in later rounds. It appears that expecting PersuadeMe's virtual money to act as a financial incentive for Innovators to act on Investors' suggestions did not serve our intended purpose—that of linking game play to the real world. It is our hunch that PersuadeMe dollars were not valued in game play. Currency in the real world can be used to procure material goods and services. Finally, the PersuadeMe prototype developed through funding from The Bill & Melinda Gates Foundation did not offer opportunities for spending the game-play money. Any future research into the potential for PersuadeMe to motivate Innovators to act on Investors'

suggestions would do well to have a marketplace incentive in place at the start of a tournament.

Conclusions

By refusing (out of practicality) the Western mind's need to "divide between knowing *subjects* on the one hand, and *objects* of knowledge on the other" (Law, 2004, p. 132), we avoided disqualifying non-human data on the premise that such data had no agency in and of themselves. Nothing could be further from the "truth" when viewed within New Materialism. By not assuming that we could *know* our participants (even if the university's human subjects board had granted us the right to report on the human actants' activities in our study), we were free to focus solely on the non-human actant's (i.e., PersuadeMe's) internally generated data.

Data accumulated by that system and analyzed through a New Materialist lens showed that the non-human components (i.e., the prompt, the tool, and the suggestions) enabled arguments, responses, and financial reward. Thus, PersuadeMe did elicit activity in a game-like social learning environment designed to support students' persuasive writing skills and cognitive development.

From a social theory perspective, PersuadeMe was an effective tool in that it elicited argumentation, rationales, and evidence in most rounds of game play. It also provided a means by which opinions were formed that elicited different types of argumentation, ranging from seemingly rational arguments to those based on emotions and personal preferences.

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Wilson, N.S, Zygouris-Coe, V.I, Cardullo, V., Smith, L. (2015). Exploring iPad technology integration in a middle grades science classroom: M-TPACK as a framework for developing students' science and digital literacies, *American Reading Forum Annual Yearbook* [Online]. Vol. 35.

Exploring iPad Technology Integration in a Middle Grades Science Classroom: M-TPACK as a Framework for Developing Students' Science and Digital Literacies

Nance S. Wilson, Ph.D.
Associate Professor
Literacy Department
School of Education
SUNY Cortland
P.O. Box 2000
Cortland, NY 13045-0900
(407) 451-5205

Vicky I. Zygouris-Coe, Ph.D.
Professor
University of Central Florida
College of Education & Human Performance
School of Teaching, Learning, & Leadership
P.O. Box 161250
Orlando, FL 32816-1250
(407) 823-0386

Victoria Cardullo, Ed.D.
Assistant Professor Reading Department
College of Education
Auburn University
5070 Haley Center
Auburn, Al. 36849
(334) 844-6882

Lourdes Smith, M.Ed
Reading Education Doctoral Student
University of Central Florida
College of Education and Human Performance
Orlando, FL 32816-1250
(407) 489-7012

Abstract

The affordances of technology present both opportunities and challenges for building students' disciplinary literacy practices. Science literacy, specifically, requires that students comprehend texts that have technical language, concepts, and topics removed from their everyday life experiences. This study explored the development of one teacher on the M-TPACK (Metacognitive, Technological, Pedagogical and Content Knowledge) (Wilson, Zygouris-Coe, Cardullo, & Fong, 2013) framework as she integrated iPads into classroom instruction to increase students' science literacy knowledge and practices.

Exploring iPad Technology Integration in a Middle Grades Science Classroom: M-TPACK as a Framework for Developing Students' Science and Digital Literacies

Despite the fact that technology is placed in K-12 classrooms across the U.S., the research exploring the impact of technology on teaching and learning is still relatively new (e.g., Apple, Inc., 2014; Karsenti & Flevez, 2013). Technology integration into the general K-12 curricula raises many questions about emerging pedagogies and technologies. Since some view technology as a panacea, many districts and schools are investing heavily in devices and technology systems. However, technology has been viewed as an add-on to existing pedagogical models. In the presence of global and federal initiatives for best 21st century preparation of all students, we cannot afford to ignore the need for instructional frameworks, teacher professional development, and ways to integrate technology so it builds student learning. We must recognize that technology causes a disruption in how we read, write, and communicate; thus, there is a need to learn how to harness the potential of technology to for content and literacy learning.

The iPad is a handheld device that provides opportunities for mobile learning while also requiring a distinct set of literacy practices. These practices include the digital literacy of reading the iPad screen, choosing Apps, knowing how to highlight and share in an e-book, and more. A teacher who successfully implements iPads utilizes metacognitive teaching to orchestrate her knowledge of pedagogy, students, content, and technology. She executes her instruction based upon her knowledge and her disposition to be an adaptive reflective practitioner.

When teachers decide to integrate technology such as the iPad into their classroom, it is imperative that they use a pedagogical framework that supports knowledge integration and metacognitive teaching and learning. Our framework, known as the Metacognitive, Technological, Pedagogical and Content Knowledge (M-TPACK) (Wilson, Zygouris-Coe, Cardullo, & Fong, 2013), requires that the teacher has knowledge of the technology, curriculum, students, and pedagogy to successfully implement this knowledge in an adaptive/metacognitive manner. This framework is key because it requires that teachers use their knowledge to engage in metacognitive thinking to be strategic as they engage in instruction, solve problems, and adjust instruction to meet students' individual needs rather than just assume that a teacher's knowledge alone will lead to successful implementation of the iPad for learning.

Literacy learning occurs in every content area. For the purpose of this study, we use the term disciplinary literacy when referring to discipline specific literacy. Disciplinary literacy refers to the reading, writing, discourse, listening, and habits of mind that are specific to each discipline (Shanahan & Shanahan, 2012; Zygouris-Coe, 2015). Disciplinary literacy also addresses the lack of success with general content area literacy in developing students' advanced literacy knowledge skills and content knowledge (Phelps, 2005, Shanahan & Shanahan, 2008; Zygouris-Coe, 2015). The specialized discourse of each content area requires advanced literacy instruction that is focused on the literacy knowledge, skills, strategies, and dispositions of that specific discipline.

Science literacy requires that students read and comprehend texts that are filled with technical language, concepts, and topics removed from their everyday life experiences (Fang & Schleppegrell, 2010; Shanahan & Shanahan, 2008). Scientists ask a lot of questions

about their world, although science in schools is often thought of as learning facts, and students need to see science learning as a way to make sense of their world (Zygouris-Coe, 2015).

Science teachers can use technology in a variety of ways (e.g., to take lab notes, explore data and information about different phenomena, virtual dissections labs) to support and extend students' science and literacy learning and help students acquire disciplinary literacies unique to science (Castek & Beach, 2013). Thus, in a classroom utilizing iPads the teacher must instruct students in science disciplinary literacy and digital literacy.

Digital literacy refers to the ability to use digital technology, tools, or networks to make meaning from, and with, texts in multiple formats and form a variety of sources, to locate, interpret, create, evaluate, apply, and share knowledge (about texts, data, images) from and across digital forms and contexts. Digital literacy is key to preparing students for the 21st century. It assures that students know how to learn from the digital technology tools that are part of our daily lives.

This case study explored the practices of one teacher through the lens of the M-TPACK (Metacognitive, Technological, Pedagogical and Content Knowledge) (Wilson, Zygouris-Coe, Cardullo, & Fong, 2013) framework as she integrated iPads into her science classrooms to increase students' science literacy knowledge and practice. In this paper, we use the term "practices" to refer to how this teacher combined devices, content, skills, pedagogy, and context, to engage students in science learning. The purpose of this study was to understand the teacher's knowledge and dispositions as a metacognitive teacher in the context of iPad integration in her classroom for science and literacy purposes. Data

sources included teacher interviews, classroom observations, and one of the researcher's and the participating teacher's field notes.

Perspective/Theoretical Framework

M-TPACK. Integrating iPads into the classroom requires more than simply passing out the devices and giving teachers and students access to Applications (Apps). Instead, it requires much careful planning, alignment with educational and content standards, and coaching and professional development that builds teachers' Metacognitive Technological Pedagogical Content Knowledge (M-TPACK) (Wilson, Zygouris-Coe, Cardullo, & Fong, 2013).

M-TPACK is different from other theories on technology integration, such as Technological Pedagogical Content Knowledge (TPACK) (Mishra & Koehler, 2006), because it focuses not just on the teacher's knowledge but her dispositions and decision making process when engaging in instruction using technology. M-TPACK is key to successful implementation of technology because it acknowledges teachers' knowledge of students, pedagogy, content, and technology while centering the focus on the teacher's metacognitive decision-making skills and dispositions. The metacognitive teacher responds immediately to unanticipated situations by making conscious and deliberate decisions utilizing her knowledge and dispositions (Duffy, Miller, Parsons & Meloth, 2009; Lin, Schwartz & Hatano, 2005). One example of the metacognitive teacher in action can be found in Lin (2001) who learned that the implementation of new technology into her teaching forced her to adopt new teaching routines from the presentation of material to how she had students working on math problems. A metacognitive teacher is one who recognizes the need to adapt instruction with the implementation of new technology to move

beyond using the technology as a substitute for paper and pencil tasks.

SAMR. *Substitution, Augmentation, Modification, Redefinition* model (SAMR) (Puentedura, 2006) can provide a framework for technology as teachers develop tasks to reach learning goals and objectives for course work. The SAMR model is further divided into two domains: transformation and enhancement. Enhancement includes the levels of *substitution* and *augmentation*, whereas the transformation stage is inclusive of *modification* and *redefinition* (Cardullo & Burton, 2015). The SAMR Model (Puentedura, 2006) is a useful tool for teachers and researchers to help them understand the levels of integration of emerging technologies being used in the classroom (Romrell, Kidder, & Wood, 2014). The SAMR model (Puentedura, 2006) illustrates how teachers process a task when adopting educational technology. In the substitution stage, there really is no functional change in the implementation of learning and technology; it is simply substituting one for another. In the augmentation stage, technology acts as direct substitution of the task, with some functional improvement. In the modification stage, technology allows for the significant redesign of the task and in the redefinition stage technology allows for the creation of a new task, a task previously unconceivable (Puentedura, 2006). The iPad is a device that is mobile and shares some of the capabilities of a full computer. The Applications in the iPad give it the power of a traditional laptop where its size puts it in the realm of mobile technologies.

Research on the use of mobile applications for academic purposes have demonstrated that effective and consistent use of particular applications will improve academic achievement (McClanahan, 2012; Perkins, Hamm, Pamplin, Morris, & McKelvain, 2011). This and other related research, along with the promise of less expensive and updated e-books, hands-on personalized experiences, and device adaptive

capabilities such as speech recognition and text to speech (D'Orio, 2011) have resulted in widespread adoption of iPads into K-20 classrooms. Additionally, iPad integration has demonstrated a positive impact on learning through active engagement, increased time for projects, improved digital literacy, and digital citizenship (Chou, Block, & Jesness, 2012). The use of the iPad as a tool for content delivery offers new learning spaces (Shih & Mills, 2007) and has the potential to change the culture of teaching and learning.

Disciplinary science reading. In order to learn effectively in the disciplines, students need instruction that will provide them with effective strategies for comprehending science texts and for applying science knowledge (Craig & Yore, 1995; Fang, 2005). The integration of iPads in science literacy instruction can provide authentic and engaging experiences for students as they interact with the iPad for academic learning. The use of the iPad also provides a tool for aligning science content to the requirements of the Common Core State Standards (CCSS), which view media and technology as an integral part of college and career readiness (NGA & CCSO, 2010). Students' use of iPads built upon their digital literacies as they employed digital tools and resources to make sense of science content, build knowledge, and share ideas (Kiili, Mäkinen, & Coiro, 2013). We believe that effective integration of technology in the classroom requires the teacher to make metacognitive curricular, instructional, and pedagogical decisions. This case study is an in-depth examination of a fifth to eighth grade science teacher's journey from the initial adoption of a class set of iPads through her stages of implementation and redefinition of her instruction through the lens of the M-TPACK and SAMR models.

Methodology

This study took place during the course of a single school year. It was the teacher's initial adoption and implementation of iPads to teach fifth to eighth grade science. The teacher volunteered to participate in the study in exchange for additional support regarding the iPad. Prior to the study the teacher had no experience with iPads and was adopting only because, it was part of her teaching assignment. The school had purchased a class set of iPads for the teacher to use and expected regular implementation of the technology. The school was a K-8 small high socio-economic school located in a Midwestern suburb. The teacher had a Bachelor's degree in science education and a Master's degree in curriculum and instruction. She also had 20 years of teaching experience with 11 years in self-contained upper elementary classes and nine as a sixth, seventh, and eighth grade science teacher. The students in this study were in grades five to eight. There were a total of 70 students in the four grade levels.

Data collection. Data were collected throughout the course of the school year through a variety of techniques. The teacher and researcher met on a weekly basis to discuss iPad usage and experiences, science literacy techniques, and the incorporation of the two. Throughout these meetings there were four formal interviews regarding iPad adoption and implementation as a tool for building disciplinary science literacy. The researcher observed the teacher and collected artifacts throughout the course of the year. The classroom teacher kept a journal of teaching experiences and aligned them with the artifacts she chose to include in the study. The artifacts were organized around the CCSS for the teaching of literacy in science and technical subjects. The data was collected through a

combination of field notes, audio recordings of teaching and weekly meetings, email correspondence, and artifacts such as lesson plans and student work samples.

Data analysis. Data was analyzed in a recursive manner using both grounded theory and constant comparison (Straus & Corbin, 1998). This approach of data collection allowed for the data to lead to weekly meetings with the teacher to assure that coaching conversations were based on helping the teacher build students disciplinary and digital science literacy. After three of the four formal interviews, researchers reviewed the data as a whole to analyze how the teacher was successfully integrating the iPad as a tool for disciplinary science literacy. As data was collected, we were able to generate emerging conclusions, which, in turn, drove subsequent observations and interviews. Tentative conclusions developed through a process of constant comparison as the emerging themes were checked and compared with the incoming data and allowed to evolve with the new information while remaining true to the previous data.

The second stage of data analysis allowed for an aggregation of instances (Stake, 1995) to determine themes and findings based on Puentedura's (2009) SAMR model and Wilson, Zygouris-Coe, Cardullo, & Fong's (2013) Metacognitive Technological Pedagogical Content Knowledge (M-TPACK) frameworks. The second stage of analysis led to the creation of two codebooks. The first codebook went through two revisions. The first version was established by a review of the characteristics of each area of the M-TPACK model. The codebook was then applied to the data by three of the researchers. After this initial analysis, inter-rater reliability was only 90%. Therefore, there was a revision of the codebook based on conversations around ten percent of the data. The data was recoded using the revised codebook with 97.4% inter-rater reliability (See Table 1 for codebook 1).

Table 1

Codebook 1

Codebook 1 (90% inter-rater reliability)	Codebook 1 Revised (97.4% inter-rater reliability)
General Use of technology Knowledge of Content Knowledge of Technology • Internet Use • Google Docs • iPad Specific Knowledge of Pedagogy • Classroom management • General Reading • Use of video/multimodal literacy Knowledge of Student • Student knowledge of iPad use Metacognitive Teacher • Decision-Making about technology • Decision-Making about adaptive Instruction	General Use of technology • Discipline Specific Ways to use the iPads • Further/extended use of technology due to iPad Knowledge of Content Knowledge of Technology • Internet Use • iPad Specific Knowledge of Pedagogy • Modeling • Classroom management • General Reading • Use of video/multimodal literacy Knowledge of Student • Student Learning as a result of technology • Student knowledge of iPad use Metacognitive Teacher • Interaction of pedagogical, content, student and technology knowledge • Decision-Making about technology ○ How technology is changing instruction • Decision-Making about adaptive Instruction

The data was also coded using a second codebook by two researchers (see Table 2 for Codebook 2). The second codebook was developed using the framework of the SAMR model (2009) for analysis of instances using the open coding process. Open coding is the process breaking down, examining, comparing, conceptualizing, and categorizing data (Strauss & Corbin, 1998). The categories and operational definitions were defined for the organization of the final coding. Substitution was defined as using the iPad as a direct tool

to substitute paper and pencil tasks with no functional change to the task. Augmentation was identified when the iPad was used as a direct tool substitute with no improvement to the specific task. Modification was identified when technology allowed for significant task redesign. Finally, redefinition was used as a code when the iPad allowed for the creation of new tasks that were previously inconceivable without the technology.

Table 2

Codebook 2

Code Name	Operational Definition	Characteristics
	SAMR Model	
Substitution	Technology acts as direct tool substitute with no functional improvement.	Notability: note taking, writing, summarizing
Augmentation	Technology acts as direct tool substitute with functional improvement.	Creating files, web search, electronic graphing, Notability for drawing, quizlet, shared information using Google drive
Modification	Technology allows for significant task redesign.	Video recording, take notes, drew diagrams, shared notes and responded to questions electronically
Redefinition	Technology allows for the creation of new tasks that were previously inconceivable.	Virtual labs, i-movie, Webquest, Prezi, electronic poster presentations, brochures

The utilization of the two codebooks provided a window into both the teacher's metacognitive pedagogical content knowledge and the level of iPad integration in her science classroom. The results are described first by the findings from each codebook and then through a compilation of the data to illustrate how disciplinary and digital science literacy instruction was achieved. Throughout each analysis, notice how the primary tool used by the teacher was the application Notability for students to record lab reports and take notes in class. This application allows for typed and handwritten note taking, sketching,

audio recording, taking pictures, annotations of PDFs, and the development of charts to name a few functions.

M-TPACK: Integration of knowledge required teacher adaptation

The following section will describe the analysis of the data based upon the M-TPACK framework. Figure 1 provides a visual of the framework and how the data was analyzed.

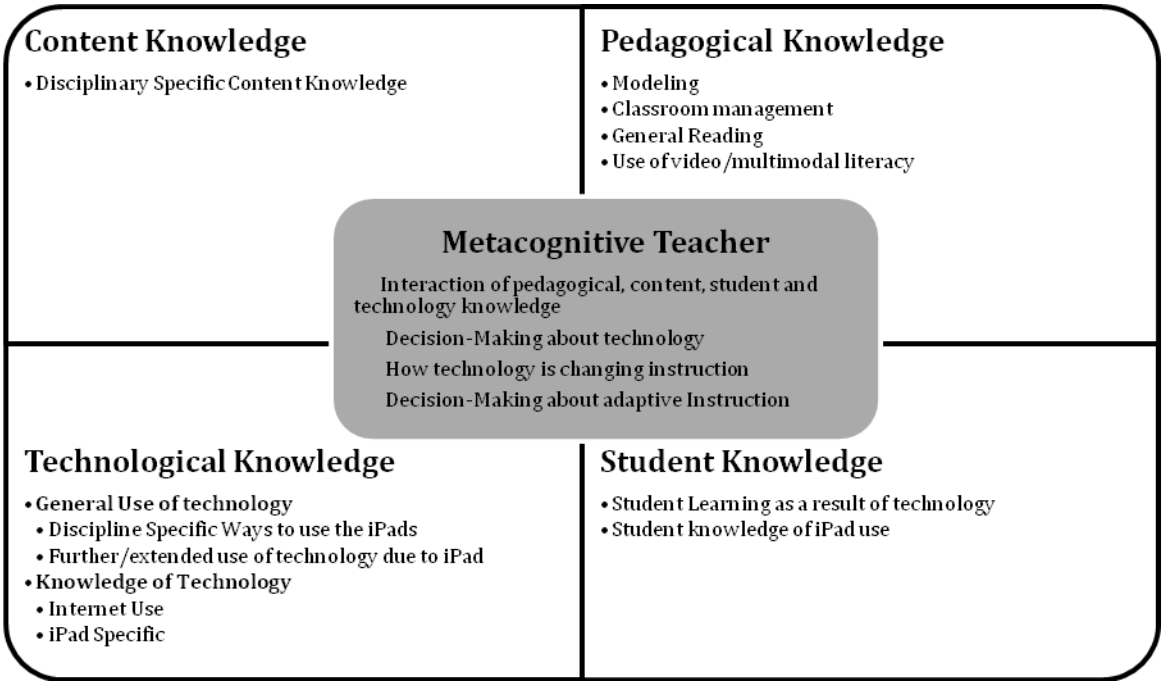

Figure 1. M-TPACK This figure illustrates the elements of the M-TPACK framework.

Pedagogical knowledge. Integration of iPads in the classroom presented new pedagogical challenges for the teacher. The use of iPads required the creation of new routines, such as charging iPads, signing in and out of accounts, location, access, and use of iPads. These routines took time to develop and required revision as student use of the iPads increased throughout the school year. The pedagogical shifts in the classroom management were short term, but key to iPad implementation in the first quarter of the school year.

When discussing the preparation and use of the iPad and Notability in the classroom, the teacher reflected on both the pedagogy and required routines. When discussing some aspects of developing routines, the teacher said, “I finally figured out too that I need to assign them each a number for the iPad and keyboard. I just went down the list. You are responsible for charging number 1” (iPad meeting, September 19, 2013). She continued, later noting, “we lost one today (keyboard) but we found it because N was absent and he didn't know his number. He just grabbed one” (iPad meeting, September 19, 2013). Although seemingly minor, these types of steps and situations are needed to ensure good time-management and routine consistency when using technology. This is an important part of the early stages of implementation of new technologies in the classroom.

Modeling and providing examples also offer a way to enhance the experience for learners. The teacher noted, “I have been doing a lot of modeling with them...Like today with the 8th grade. I said this is what I expect when you are on your own. So they have an example and say this is how she wants me to write it. This is what she wants me to do” (iPad meeting, September 19, 2013). This comment demonstrates the teacher’s understanding regarding the importance of modeling how new technologies can be used along with the providing examples for the students resulting in desired expectations for the product.

In addition to supporting students by modeling, the teacher began to understand that creating models and examples may not be enough for assisting learners with new technology. The teacher reflected on this notion when she said, “you know like I went through and did the whole Notability thing. I did an example or whatever, to see what kinks, until you really do it, some of those kinks don’t come through. You have to think

ahead. You have to do it with the class once to find some problems. You can't think through every challenge" (iPad Meeting, September 19, 2013). Building technology examples in isolation, without others' input, may lead to an incomplete picture of what is needed to support learners. Understanding that practicing new technologies with students can support pedagogy is another piece to the puzzle for good implementation. This reflects the need to provide time to develop a pedagogical understanding of the technology alongside her existing pedagogical knowledge to science teaching.

Although the teacher had previously used an inquiry model of teaching and learning, the iPads presented new pedagogical challenges from the creation of routines for keeping the iPads charged and organized to transferring pedagogical practices, such as recording observations in experiments. Considering the use of Notability and iPads in the classroom, the teacher reflected on the process by saying,

> Finally, by October 25th I had the students type and write responses to pre-assessment questions on rocks in Notability right away! They also looked at samples of rocks and added their observations to their note in Notability with their questions. I had handouts from a Rock and Minerals workshop that I used for their Rocks labs, however I did use the iPads to take a picture of the worksheet to project it on the Smartboard to refer to it. This worked well because our school did not have Elmos. As they played the rock cycle game, they recorded the information on each dice into their Science notebooks, ugh, why not use the iPads? I did incorporate the iPads in a note I shared with them of 8 pictures of Sedimentary Rocks in which they needed to identify. (6th GRADE Reflective Notes, n.d.)

This quote demonstrates how the use of the iPad and Notability played a role in pedagogy, but also how the teacher struggled with using the technology in the classroom for other activities. As time passed, she increased her use of iPad- based writing activities instead of "paper" in the classroom.

Technological knowledge. At the beginning of the year, technological knowledge had a huge impact in the teacher's integration and use of the iPads. Her lack of knowledge led her to have students create "paper" science journals. As her knowledge of the iPad grew, specifically her knowledge of the Notability App, she transferred the students to e-science journals, which included multiple texts (e.g. drawn images, photos, and written notes in single documents). In addition, her use of technology in the classroom increased with specific ways to support learners with on-the-spot activities separate from their "paper" science journals. This is reflected in the teacher's actual use of technology via an observation during March of the same school year.

> The students are reading an article on the Iditarod website and responding to it on Edmodo right now. Samantha Says 'This is fun, it's like we are texting'. And Ned says, 'we don't even have to talk to one another.' The assignment is to reply on Edmodo to what they are reading in any way, but include any words that are unfamiliar to them. They can respond to a classmate's reply and help them out if they can to understand vocabulary. The article discusses the trail from Cripple and the lack of snow and the impact it is having on the mushers/dogs. We will be relating this to our biome essential question. (Email, March 6, 2013)

The use of Edmodo, another technological application, provides students with the ability to discuss the reading online and allows interaction between multiple students at one time

rather than the limited contact in a small group via their "paper" journals. Understanding how to support learners using this type of technology demonstrates a possible switch in thinking from the earlier considerations of the teacher having a majority of work done in the usual manner.

In addition, the teacher found that she did not have to stand-alone and be the only teacher in the classroom when using and explaining how to implement technology. She notes, "even though we were having trouble with the whole Notability, sharing it with me whether to email it or Google drive. The whole process of doing that, the kids were like…It was a good process for the kids to work together because one always knows what to do. So someone would say I thought you would do this and someone else would say no you do this. So it is kind of like there is some good collaboration there. They did well with it" (iPad Meeting, September 19, 2013). Through the use of technology, the teacher's general knowledge of how to use the technology in discipline specific ways grew along with her knowledge of using the iPad in general. She also learned how to manage and address student knowledge of the technology.

Student knowledge. At the beginning of the implementation, the teacher believed that the students as digital natives would move seamlessly into the iPad use in her science classroom. Digital natives are considered as those that have been immersed in technology since they were of a young age and require a digitally and technologically enhanced learning environment in order to learn and prosper in and beyond their educational environment (Prensky, 2001). However, she soon learned that the students were not used to using the devices for learning. She learned that she needed to focus the students on how to search effectively and how to read images. There was a cadre of students who did understand the

workings of the iPad, such as finger movements and button pushes. This was helpful for the management of device use on a daily basis. Although it did improve efficiency for classroom use, it did not guide students in learning from the iPad. Using the device for learning was something that needed to be taught.

One lesson included helping students to learn how to examine images to build scientific knowledge. The teacher reflects on this by noting the use of finding quality, Google images. She says,

> … I used one of the Google images to kind of teach to them why they are called the way they are and where they are and not. They had to look through the images and choose three and then they put it in Notability and they copied them into Notability and um ...this is mine (shows me hers). Because I told them that I wanted them to choose three that they understood, that made sense to them and that they could study from. And so then I thought, so here is mine. I have four here because I used some to teach other things. So here is the best one, these are all the parts I wanted them to learn. But this picture didn't work for some kids because of the three dimensional look. So, some of it worked better with this. We talked about the ....there are a couple of activities that we are going to do on oxygen and the clarity of the water next week; but um...but this one worked better for Paul because it had both sides of the lake. (Cindy Recording, May 6, 2014)

Students benefit from not only being shown how to find quality images, but also from understanding the processes underlying how to evaluate and determine if the images that enhances understanding. Both the teacher and the student had to go through a process of what was effective and useful when determining which image increased content knowledge

and could be best used for studying. In addition, a discussion of the process and consideration of why some images worked better than others for some learners was beneficial as it allowed the students to practice digital and science disciplinary literacy skills. A final representation of how students used different images to build there knowledge is illustrated in Figure 2.

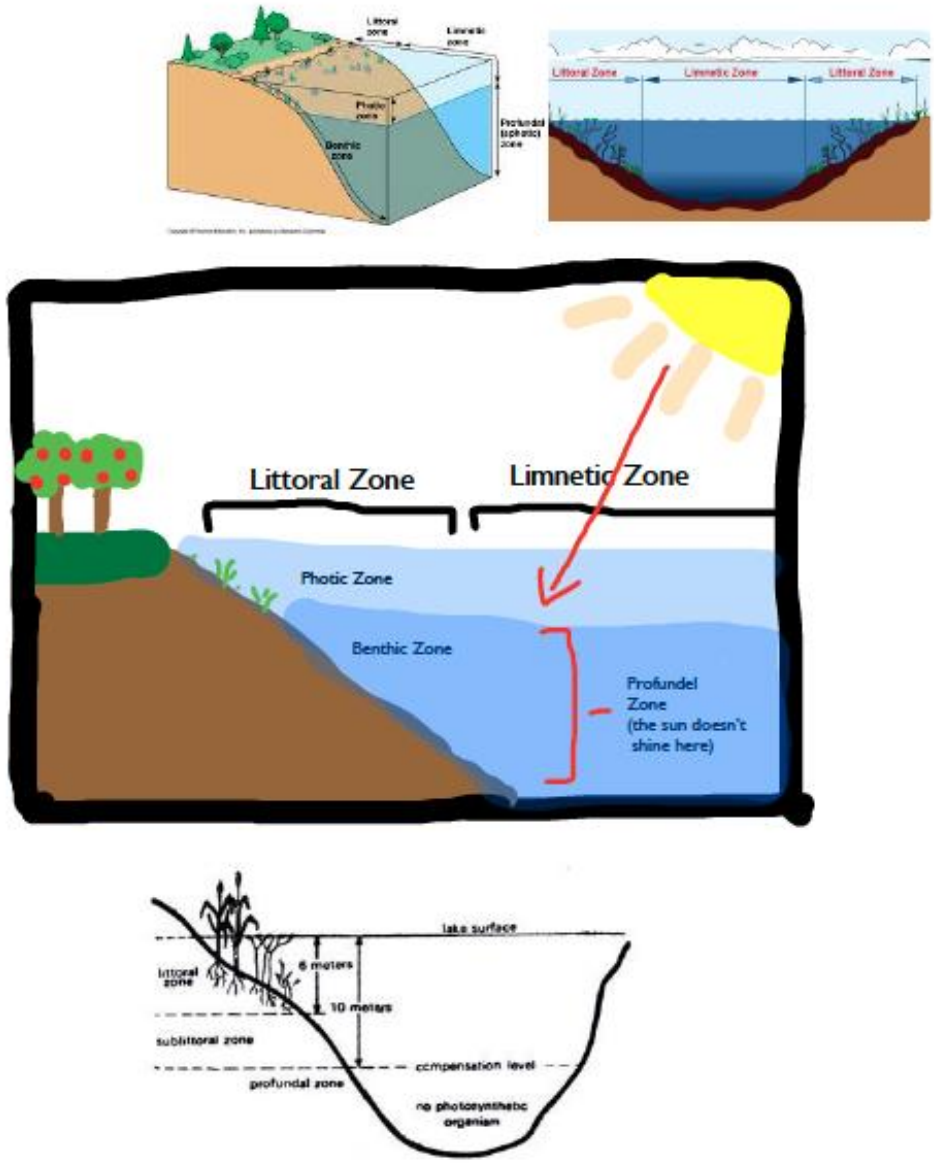

Figure 2. Zones of the Lake Ecosystem. Demonstration of various images.

Content Knowledge. At the start of the implementation, the focus of the weekly meetings was on pedagogy, technology, and students. As the teacher became more comfortable with iPads and disciplinary science literacy, the conversations shifted to illustrate her depth of content knowledge. These conversations began with a discussion of the content she needed to teach, an explanation of the content and what she hoped students to understand about the content. This discussion then moved to the best ways to have students illustrate their knowledge of the content using the iPad. This is reflected in the words of their teacher regarding use of the searches to support content knowledge, as well as why and how illustrations were chosen. She says,

> Doing some research and looking for a real picture of how you would see it under the microscope. Not a drawing, not an animated or whatever. A real photo and then I have this that I gave them copies of this {shows a plankton identification handout} at the microscope so that as they are looking they can see what they look like. Um, these are the ones that they will see. And then, what I would like to do is I would like to do one little activity though although it's not even in the course of study, I don't even care. To teach them about where these organisms are in the water as far as the zones of the Lake, you know. We dredged these up from the bottom and we learned the word benthic you know bottom layer and .... (Cindy Recording, April 29, 2014)

Although the use of paper handouts were still being used, the teacher is reflecting on having students use the Internet to find authentic photos of discipline specific words in order to increase content knowledge of the text. The teacher noted that the use of the Internet

allowed her to go deeper on related materials in order for students to gain a more in-depth look at the content being covered.

The metacognitive teacher. During the course of iPad integration the teacher's metacognitive decision making increased. She made changes to her teaching to assure that objectives were being met. She offered suggestions for different ways students could address a problem. She reflected on how to use her knowledge of students, technology, content, and pedagogy to alter instruction. Additionally, the teacher's metacognitive teaching disposition was observed throughout the study as being affected by school factors (i.e., class interruptions due to schedule changes), student factors (i.e. knowledge of how to save work to Google drive), iPad factors (i.e., choosing the right app to meet curricular goals while considering student knowledge of the app and content and the pedagogical implications of the app), and curricular factors (i.e., the required curricular content), among other factors. The teacher reflects on this when considering her way of having students review school work by saying, "…28 years of paper and pencil. I still like thinking about how I can use the iPad. I am thinking more creatively; but I could have them do things like the section review instead of having them turn in their paper" (iPad Meeting, September 19, 2013). Connecting with not only the content, but being aware of the needs of the student with regard to what the students' needs are for future instruction makes the teacher note that the students, "couldn't hear my voice very well and we had to figure out the whole volume issue because there is a volume button in Notability and there is a volume button on the iPad. You know, there are all of these volume buttons to check out. So you know even .... I should have....next time I would go over some of those things, microphone, volume, with them" (Cindy Recording, April 29, 2014). She considers her own processes and

understanding of technology needs when she says, "I am at the point where I ask myself, how can I do this activity using the iPads, or how can the students show me what they know using the iPad as a form of assessment? Have I used them too much with a group?" (Cindy iPad Reflection, November 14, 2013). Throughout the study, the teacher adjusted her teaching to the content, learning, and iPad use needs and her "metacognition served as a mechanism for problem finding, for setting adaptive goals, for identity building, and for value clarification" (Lin, Schwartz & Hatano, 2005, p. 249).

The SAMR Model: Looking at the degree of integration

In this section, data analysis and results are presented by using the SAMR model lens. The data demonstrates that the teacher was using the technology for enhancement and transformation.

In the fall, the teacher used the iPads mostly to modify traditional paper and pencil tasks. For instance, the students used iMovie to record a demonstration and explanation of surface tension and the teacher used Notability to have students insert images of animals with symbiotic relationships. She also used the iPad to augment traditional paper and pencil tasks when she chose to use the Notability app for learners to draw diagrams of mealworms; additionally, she used Quizlet to practice vocabulary, writing summary of notes on atoms and molecules in Notability, and shared responses to questions using Google Drive.

After a semester of using the devices, iPad use became more varied. There was evidence of substitution when students typed observations from their experiments using Notability. Yet, pure substitution of tasks was more often replaced by augmentation as evidenced in how this teacher had her students use Notability to type questions they had on praying mantises, and then used the Internet to research answers; hen she asked students to

use the Internet to partner read, type notes in Notability, and watch video on biomes from the Internet; and by regularly having students use Notability to record lab notes. Lab notes included images and diagrams taken and created with the iPad. The teacher continued to modify her teaching using the affordances of the iPad as evidence of students' use of Edmodo to respond to questions comparing the Biomes of the Desert and Alaska, and to have an asynchronous discussion on the biomes and when students collaboratively answered questions about algal blooms in a new document in Google Drive. These tasks led to the teacher's use of the iPad to redesign how she used Notability as a multimodal science journal by having students read over their notes in Notability on waves, then asking students to draw waves into Notability note, and label the parts of the waves. Once this part of the project was complete, learners attached images from the web to illustrate key ideas and then the teacher used images of the posters taken on a field trip to a lake to help students identify organisms under microscope from the sample brought back from trip. Students typed notes in Notability to insert images of plankton and to demonstrate their understanding of the content.

The analysis of the data through the lens of the SAMR model not only showed how the level of integration, but it demonstrated how implementation changed over the course of the year. These changes occurred as the teacher was engaging in metacognitive teaching using her knowledge of students, content, pedagogy, and technology to influence her decision making process. As her knowledge changed so did the decisions she made about how to implement instruction; over time, data showed that technology changed her instruction.

Discussion

This research examined a 5th through 8th grade science teacher's disciplinary literacy instruction using iPads through the lens of the M-TPACK framework and the SAMR model. This research used multiple classroom observations, interviews with the teacher, and review of classroom artifacts to provide descriptions of how the M-TPACK (Wilson, Zygouris-Coe, Cardullo, & Fong, 2013) and the SAMR (Puentedura, 2006) models can be used to describe how iPad use for academic purposes transforms teaching and learning. This teacher adapted her instruction to assure that students gained the digital literacy necessary to be successful with the iPads, while at the same time she used it to develop their science knowledge. Sometimes the change in instruction was simple; for instance, using Notability to share class notes with the students so that students could add to those notes). Sometimes it was more complex; for instance, having students use Edmodo to engage in asynchronous discussions about science content. The moves made by the teacher were almost entirely in response to the integration of the iPad into the classroom and her focus on disciplinary science literacy.

It is evident from the data that the teacher monitored students' progress, her curriculum goals, the effectiveness of pedagogy, and the use of technology to make metacognitive instructional decisions, the curriculum goals, the effectiveness of pedagogy, and technology to make metacognitive instructional decisions. Specifically, the teacher addressed the role of technology, the iPad and applications, her planning, and all it entails in order to support her students' progress and her instruction. She questions herself early on asking, "how can I do this activity using the iPads, or how can the students show me what they know using the iPad as a form of assessment?" (Cindy iPad Reflection, November 14,

2013). She considered the role of technology and was inquisitive on exactly why things are changing when saying, "…they are just practicing. They were less asking me questions on how to do it. They were just in it. I am going to figure this out. It is just the nature of the group. They were more willing to experiment. They thought it was fun and exciting and whatever" (Audio 5_22_14, May 22, 2014). These actions demonstrated that it is through the integration of all areas of knowledge that the teacher made metacognitive decisions that led to instructional adaptations and integration of the iPad to promote students' science (and technology) learning. These practices showed evidence of a metacognitive teacher who recognized the need to adapt instruction with the implementation of new technology and moved beyond using the technology as a substitute for paper and pencil tasks.

The nature of the study's research design and the use of a convenience sampling (Salkind, 2010) have inherent methodological limitations. The research design allows us to examine a new phenomenon (i.e., iPad integration in a science classroom for academic purposes). Results from the convenient sample (Kemper, Stringfield, & Teddlie, 2003) cannot account for generalization, adequate representation, and replication. Built-in bias and validity were addressed through triangulation and constant comparison methods. Although generalizability of findings is limited to the participating sample, both the M-TPACK (Wilson, Zygouris-Coe, Cardullo, & Fong, 2013) and SAMR (Puentedura, 2006) frameworks could be used as lenses for analyzing the role of technology integration in teacher and student content, literacy, and learning practices.

Educational Significance:

Researchers in digital literacies (Leu, Kinzer, Coiro, Castek, Henry, 2013; Coiro & Dobler, 2007; Lankshear & Knobel, 2003) recognize that the spaces in which we construct

literacy are evolving. Findings from this research indicate that the advent of new literacies and the introduction of an iPad for academic learning have forged new cognitive monitoring issues for teachers (i.e., new technologies, new formats, new content). Teachers must be able to allocate and monitor these cognitive resources and adjust their teaching. Teacher preparation and continuing education in technological literacy requires professional development dedicated to instruction on the use of multimedia devices, such as the iPad, for learning in the classroom. It also requires that the teacher's disposition as a metacognitive teacher be further explored for the purpose of identifying how to use these technologies to teach students the necessary content, literacy, and technological strategies and skills necessary for learning and college and career readiness.

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Predicting Early Reading Achievement: Identifying Effective Assessment Tasks

Nora Vines, Appalachian State University

Abstract

This study examined the relations among two strong, early predictors of reading achievement. Building on the work of Morris, Trathen, Schlagal, Gill, Ward, and Frye, (2013) the present study compared the predictability of a sight word task and spelling task on a contextual reading task. Data from the Morris et al. study were used to evaluate the relations among independent variables (sight word and spelling tasks) and a dependent variable (words read correctly per minute on a contextual reading task). Student performance on the sight word and spelling tasks at three time points in first grade and one time point in second grade were evaluated on the ability to predict words read correctly per minute at the end of second grade. Relations among variables in first grade were also examined.

Over the past 15 years, two sets of federal legislation—the *No Child Left Behind Act* (NCLB) (U.S. Department of Education, 2001) and *Race to the Top* (2009)—have greatly influenced how American children are taught to read in the early grades (kindergarten through third grade). Now, more than ever, in this age of high-stakes testing, classroom teachers need effective assessment measures which they can use to identify those students who are struggling, identify those students who may struggle later, and inform instructional practice.

The present study was designed to expand on Morris, et al. (2013) longitudinal study which compared a prevalent assessment system employed in many states and school districts across the country. In comparing *Dynamic Indicators of Basic Early Literacy Skills* (DIBELS) (Good, Kaminski, Cummings, Dufour-Martel, Petersen, Powell-Smith, Stollar, & Wallin, 2011) tasks with tasks developed by Morris and colleagues, the researchers found that the assessment measures were more highly correlated with reading achievement than measures employed by DIBELS.

Given the critical need for effective, informal reading assessment in kindergarten and first grade, and the potential shown by formative tasks in the Morris et al. (2013) study, the present study further examined specific tasks used in that study, namely *spelling* (orthographic knowledge) and *sight word knowledge*. The goal is to see which of these two tasks, administered at different time points in first grade (T1, T2, and T3), and second grade (T4) is the better predictor of an of end-of-second-grade measure of reading fluency (T5).

Theoretical Framework

If the goal is to understand how word recognition develops in beginning readers, then one needs a theory—an explanation of how word recognition progresses or improves over time.

Fortunately, there is some consensus among educators and psychologists on this matter, and this agreement is captured in Linnea Ehri's (1998) model of early *sight word* development.

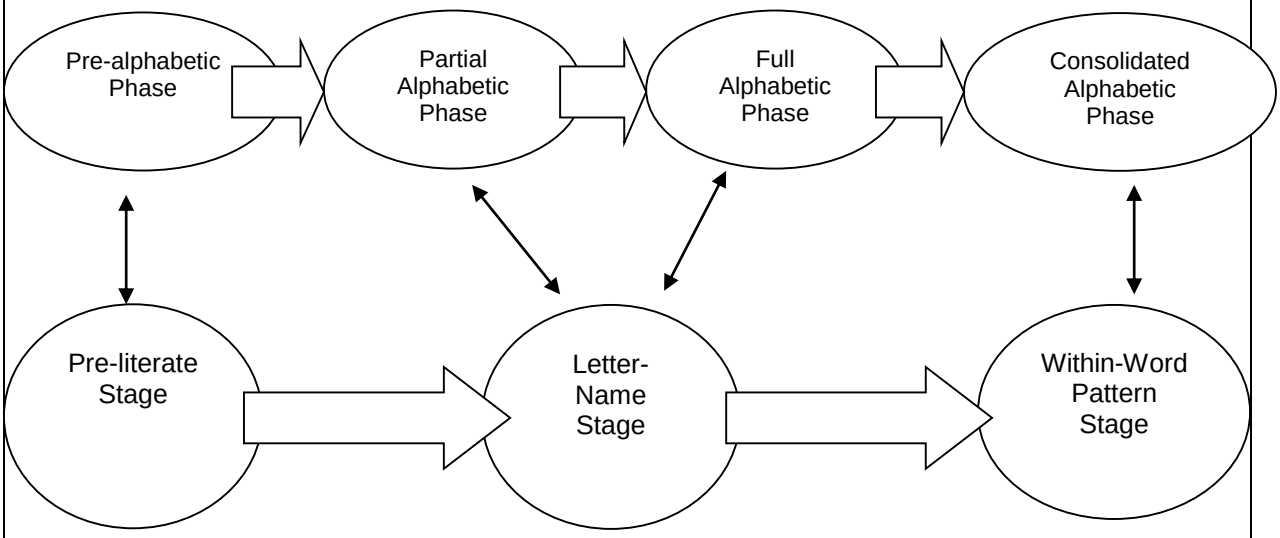
Ehri's Model of Sight Word Development

Ehri's (1998) phase model of word learning outlines the beginnings of reading acquisition. The model is specific to sight word acquisition, but is also closely tied to the development of spelling ability. The meaning of *sight word* that pertains to this study refers to printed words, of various difficulty levels, that are recognized accurately and automatically on sight. Ehri (1998) describes four phases of sight word development in young readers.

Henderson's Stage Model of Spelling Development

Sight words are acquired by the learner forming connections between sounds in the pronunciations of words (phonemes) and the letters (graphemes) in spellings that represent those sounds (Ehri, 1998, 2005). Learning a sight word requires that the reader attend to the spelling and pronunciation of the word. The reader is able to recognize the phoneme to grapheme matching in the word and after reading the word multiple times, it is secured in memory by those phoneme to grapheme connections (Ehri, 2005). Therefore, learning to read and spell in English are reciprocal processes (Ehri, 1998). The development of one, more often than not, reflects the development of the other. Ehri's phase model is supported in large part by the developmental spelling model put forth by Edmund Henderson (1981).

- Figure 1. Ehri's Phase Model of Word Learning and Henderson's Stage Model of Spelling Development.



The arrows between Ehri's Model (top) and Henderson's Model (bottom) indicate the alignment of word knowledge in reading and spelling across both models.

Share's Self-Teaching Hypothesis

Share's self-teaching hypothesis asserts that decoding, the process of matching graphemes to phonemes in order to pronounce words, is the key to beginning readers increasing their abilities to accurately and automatically recognize written words (Share, 1995; 2008). Orthographic knowledge is critical for visual recognition of words, a process central to self-teaching. An example may help here. Think of a first grade boy reading the following sentence, "The cat likes to play with bugs." Possessing a few sight words and some phonemic awareness, the child might be expecting the following spelling of the new word *bugs*: B-O-G-S. Upon seeing the U spelling of the vowel, the child has a chance to process, and store in memory, the correct spelling of the word. This example shows that successful decoding attempts with new letter strings (e.g., *bugs*) provide opportunities to establish correct word representations in memory (see Perfetti, 1992).

When the reader has a rudimentary knowledge of orthography and a minimal sight word vocabulary, the self-teaching mechanism is activated quite early, allowing the reader to decode some of the unknown words encountered in contextual reading. This self-teaching model is item-based. That is, the reader uses known sight words, orthographic knowledge, and phonological knowledge to decode novel words. In addition, the self-teaching mechanism develops in tandem with the reader's development in word reading as outlined by Ehri (1998) and knowledge of orthography as outlined by Henderson (1990). As the reader continues to develop these knowledge sets, she acquires, through the act of decoding, the specific orthographic representations of words required for automatic recognition (Share, 1995). Furthermore, while the model is item-based in word recognition, the orthographic structures of successfully decoded words can be used to read novel words with the same, or similar, structures by analogy (e.g. knowing *night* and *right*, the young reader may be able to recognize *bright*.)

This study is concerned with the developing printed word knowledge of first-grade readers, the accurate assessment of the development of this knowledge, and its ability to predict later contextual reading fluency. Therefore, Ehri's and Henderson's descriptions of *content* (characteristics of word knowledge phases) and Share's description of *process* (self-teaching) will both be helpful in interpreting or making sense of the data collected.

Ehri's phase model of word learning, Henderson's stage model of orthographic knowledge development, and Share's self-teaching hypothesis highlight the steps necessary to become a fluent reader. Although reading acquisition is a lifelong process, the hallmark of mature reading is the ability to read connected text with fluency, automaticity, and understanding (e.g. Ehri, 1998; Perfetti, 1985; Laberge & Samuels, 1974).

Words Correct Per Minute

Words read correct per minute (WCPM) is a measure of oral reading fluency. This measure gives insight into the child's reading ability with varying levels of text. Reading fluency, sometimes referred to as reading rate, can indicate whether a reader's issues are in making meaning, which can be a deficit in vocabulary knowledge, prior experience, or syntactic knowledge, or if the issues are at the print level. Print-level deficits can stem from lack of sight word knowledge, delays in orthographic knowledge development, inadequate decoding skills, or phonological awareness/processing deficits. Guszak states: "The fluency or rate with which a pupil reads materials reveals rather clearly whether pupils are having meaning or word recognition difficulties with text" (p. 24, 1997). The minimum oral rate for reading first grade reading materials, according to Guszak, is 60 words per minute. For second grade materials, the minimum oral reading rate is 70 words per minute.

> Because rate is such a useful indicator of word recognition and comprehension, it is the first screen that a teacher should apply as he observes a pupil reading self-selected text. Such verification can provide support as to whether the pupil is prospering or suffering in that text. If the rate is fast and fluent the student is obviously doing well. If, however, the rate is near or below the minimums, there is strong reason to question why that pupil is reading so slowly. (Guszak, p. 73, 1997)

The importance of reading fluency, as measured by WCPM, is supported by the work of Ehri (1998; 2005), Henderson (1990) and Share (1995). Reading acquisition begins in the earliest grades, and in order to facilitate these processes, reliable and efficient assessments must be available for use in early identification of those students who may struggle with learning to read.

Methodology

Data used in this study were collected as part of a longitudinal study that began in the fall of 2010. Specifically, Morris et al. (2013) were concerned with how their formative assessments compared to subtests of the DIBELS assessment (Good et al., 2011) in terms of predictive validity. A subset of the data from that study was used in the current study to examine the relations between the sight word task (SW) and the spelling task (SP) at the beginning (T1), middle (T2), and end of first grade (T3). I also examined SW and SP at the middle of second grade (T4), and WCPM at the end of second grade (T5). The relations between SP at T1, T2, T3, T4, and WCPM at T5 were also examined.

Participants

The participants were first graders (N= 127) from two rural school systems in southern Appalachia. All students were participants in a longitudinal study across grades kindergarten, first, second, and third. This study looked specifically at measures taken during first and second grade.

Assessments

Students were tested individually at three time points during the first grade school year (T1, T2, and T3) and two time points during the second grade school year (T4 and T5). Assessments that targeted key components of print processing (i.e. word recognition in isolation, oral reading accuracy, and word attack skills) were used. The study design can be found in Figure 2.

	Fall First Grade (T1)	Winter First Grade (T2)	Spring First Grade (T3)	Winter Second Grade (T4)	Spring Second Grade (T5)
Sight Words (SW)	X	X	X	X	
Qualitative Spelling (SP)	X	X	X	X	
Words Correct per Minute (WCPM)			X	X	X

Figure 2. Study Design. The assessment tasks at each time point. Words Correct per Minute T5 is the criterion measure (dependent variable).

To measure sight word recognition in isolation, students were asked to read a list of high-frequency words. The list included both decodable, pattern words and words that students could not decode using knowledge of letter-sound relationships. Students had sixty seconds to read as many of the words as possible. To measure word attack skills, students were asked to spell graded word lists. The first grade list consisted of phonetic spellings (e.g. chip, pet), while the second grade list represented pattern spellings (e.g. cloud, shopping). Finally, to measure oral reading fluency, graded passages from an informal reading inventory were used. All assessment tasks are from *The Morris Informal Reading Inventory* (Morris, 2014) and can be found in the appendices. Oral reading fluency at the end of second grade was the criterion measure.

Findings and Discussion

In order to best represent differences in student development, as well as increase variance, new variables were created in SPSS (version 20). Qualitative spelling scores were combined by computing the sum of the first and second grade scores T3 (spring of first grade) and at T4 (winter of second grade). New variables were also created for WCPM (rate). The mean

of WCPM on primer and first grade passages at T4, and first and second grade passage at T5 (spring of second grade, which is also the criterion measure). Rate was averaged to reflect the variation in student reading levels. Using only grade level passages would limit scores to only those of students reading on grade level. In a single classroom students perform at a wide range of abilities. By averaging the reading rate, scores were more reflective of student reading ability.

After computing new variables, data were screened for outliers. There was a wide range of scores within tasks, which is typical for readers at early stages of reading acquisition. Descriptive statistics were used to identify the means and standard deviations for each variable. These results are found in Table 1. The mean comprehension score of all participants was 86% (n = 127). Comprehension is reported in order to demonstrate that students were reading for understanding, not simply reading as quickly as possible. Comprehension scores were not included in any of the regression analyses because this study was specifically focused on qualitative spelling and sight word knowledge as predictors of reading achievement as measured by WCPM at T5.

Table 1

Descriptive Statistics of Variables (n =127)

	T1		T2		T3		T4		T5	
Variables	*M*	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*
SW	18.8	15.4	36.9	19.0	49.0	19.7	63.4	19.0	---	---
SP	31.5	6.3	36.9	3.93	78.0	11.7	83.6	8.1	---	---
WCPM	---	---	---	---	54.7	30.2	95.1	35.2	104.8	37.9
Comp.	---	---	---	---	87.0	27.1	86.9	18.4	88.1	24.3

Note. WCPM and Comprehension were not measured at T1 or T2.
Comprehension was not used in the regression analysis.

The analysis of descriptive statistics, specifically standard deviations, revealed a wide range of scores within tasks, which is typical for readers at early stages of reading acquisition.

Findings from this study support findings of the Morris et al. (2013) study that early spelling and sight word reading are good predictors of later contextual reading, i.e., reading fluency.

Analysis of descriptive statistics (see Table 1) revealed that scores on spelling, sight word reading, and contextual reading improved across time as students gained experience and became more proficient in reading. SW and SP especially exhibited an increase in mean scores over time (T1 to T4). WCPM mean scores also increased from end of first grade to end of second grade (T3 to T5). Because the measures were taken across time and grade levels, these trends were expected as they mirrored the growth students were making in literacy. This growth is consistent with the development of underlying word knowledge outlined in the past research of Ehri (1998), Henderson (1990), Perfetti (1985, 1992) and Share (1995, 2008).

Comprehension score means were consistently strong, which indicated students were reading for meaning during the reading of connected text task. The end goal of reading is to construct meaning (e.g. Chall, 1983; Gough & Tunmer, 1986; LaBerge & Samuels, 1974; Perfetti, 1992, 2007; Perfetti & Hart, 2002), and a rate score measured in the absence of comprehension of the text cannot be a true measure of reading achievement. Thus, this finding was important to note since many assessments that claim to measure rate, such as DIBELS, do not require students to read for understanding, but instead to read as quickly as possible.

Table 2

Correlations (n = 127)

	T1 SP	T1 SW	T2 SP	T2 SW	T3 SP	T3 SW	T3 WCPM	T4 SP	T4 SW	T4 WCPM	T5 WCPM
T1 SP	---	**.63***	**.63***	**.63***	**.63***	**.60***	**.58***	**.54***	**.53***	**.44***	**.46***
T1 SW		---	**.50***	**.86***	**.47***	**.75***	**.83***	**.45***	**.62***	**.63***	**.60***
T2 SP			---	**.60***	**.81***	**.66***	**.58***	**.68***	**.57***	**.56***	**.56***
T2 SW				---	**.59***	**.93***	**.95***	**.62***	**.81***	**.81***	**.79***
T3SP					---	**.69***	**.58***	**.79***	**.63***	**.61***	**.60***
T3 SW						---	**.92***	**.69***	**.89***	**.87***	**.83***
T3 WCPM							---	**.59***	**.82***	**.83***	**.80***
T4 SP								---	**.70***	**.66***	**.66***
T4 SW									---	**.89***	**.86***
T4 WCPM										---	**.91***

Note. * p < .01 Every correlation is significant at the .01 level.

Correlational analyses (Table 2) demonstrated strong, positive, statistically significant relations among all variables. As revealed in Table 2, every correlation was significant at the .01 level, meaning there is less than a one in one hundred instance in which the relations among the variables occurred by chance. Correlation values (*r*) of .40 to .69 are considered to indicate strong relations, while an *r* value of .70 or higher indicate very strong relations (Huck, 2008). Correlations among spelling (SP) scores across assessment time points were consistently strong, and correlations between SP and WCPM remained consistently strong and positive across time. And as expected, scores with the strongest correlations were those that occurred closer together in time.

Importantly, SP and SW were strongly correlated at all time points. The strength of the relations between SP and SW across time is substantiated by the work of Ehri (1998) and Henderson (1990) (see Figure 1). Children's knowledge of sight words and orthography develops similarly and, quite often, in tandem. While SP and SW were strongly correlated with each other, and SP was strongly correlated with WCPM, somewhat surprising, correlations between SW and WCPM were stronger than those between SP and WCPM at each time point, and increased across time also. Perfetti (1992) as well as others have argued that spelling is the best early predictor of contextual reading. These data reveal that, while both early assessments (SP and SW) predict WCPM at end of second grade, SW correlations consistently were stronger. This finding suggests that sight word reading may be a stronger predictor of contextual reading than spelling.

A possible explanation for this finding is that heavy focus on spelling instruction in first grade may have influenced the impact of the spelling assessment. That is, teaching synthetic phonics may enable children to spell words they cannot read fluently. T1, T2, and T3 spelling measures all included the first-grade spelling list consisting of simple letter to sound patterns. Such spelling patterns were the focus of synthetic phonics instruction children were receiving, so students were adept at producing those patterns. Yet, children were not able to perform as well in the contextual reading task, nor were they able to perform as well on the sight word task. Whatever the explanation, these data demonstrate a distinct advantage to using the sight word task as a predictor of later reading fluency.

The strength of relations among WCPM measures was very highly correlated and increased over time. WCPM was the criterion measure for the study; rates of students reading leveled passages for meaning was a proxy for reading achievement because it captured their

ability to rapidly recognize words in context. Researchers agree that this ability to accurately and automatically recognize printed words drives the fluent reading process (e.g., Adams, 1990; Perfetti, 1985; 1992; Rayner & Pollatsek, 1989). The rate measure also captured the transitions being made as children progress from Chall's (1983) Stage 1 into Stage 2 of reading development—reflecting students' transition from being "glued to print" to becoming "unglued," the crucial switch that must be made in order for students entering 3rd grade to begin reading for learning (Chall, 1983).

Table 3

Standard Multiple Regression of all Variables Model Summary

R	***R* Square**	**Adjusted *R* Square**
.88	.77	.76

Table 4

Results of Multiple Regression with all Variables

Variables	***B***	***Beta***	***t***	***P***
T1 Spell	-.80	-.13	-2.04	.04
T1 SW	-.15	-.06	-.67	.51
T2 Spell	.30	.03	.40	.69
T2 SW	.80	.40	2.43	.02
T3 Spell	.25	.08	.82	.42
T3 SW	-.10	-.05	-.30	.77
T4 Spell	.27	.06	.74	.46
T4 SW	1.16	.58	5.79	.00

Table 5

Hierarchical Multiple Regression of Time 4 Sight Words Model Summary

R	***R* Square**	**Adjusted *R* Square**
.86	.74	.74

Table 6

Results of Hierarchical Regression with T4 Sight Words Entered First

Variables	***B***	***Beta***	***t***	***P***
T4 SW	1.71	.86	18.80	.00
T1 Spell	-.80	-.13	-2.04	.04
T1 SW	-.15	-.06	-.67	.51
T2 Spell	.30	.03	.40	.69
T2 SW	.80	.40	2.43	.02
T3 Spell	.25	.08	.82	.42
T3 SW	-.10	-.05	-.30	.77
T4 Spell	.27	.06	.74	.46

Table 7

Hierarchical Multiple Regression of T2 Sight Words Model Summary

R	**R Square**	**Adjusted R Square**
.79	.62	.62

Table 8

Results of Hierarchical Regression with T2 Sight Words Entered First

Variables	***B***	***Beta***	***t-value***	***p-value***
T2 SW	1.57	.79	14.32	.00
T1 Spell	-.80	-.13	-2.04	.04
T1 SW	-.15	-.06	-.67	.51
T2 Spell	.30	.03	.40	.69
T3 Spell	.25	.08	.82	.42
T3 SW	-.10	-.05	-.30	.77
T4 Spell	.27	.06	.74	.46
T4 SW	1.16	.58	5.79	.00

Table 9

Hierarchical Multiple Regression of T1 Qualitative Spelling Model Summary

R	**R Square**	**Adjusted R Square**
.46	.21	.20

Table 10

Results of Hierarchical Regression with T1 Spelling Entered First

Variables	***B***	***Beta***	***t-value***	***p-value***
T1 Spell	2.74	.46	5.74	.00
T1 SW	-.15	-.06	-.67	.51
T2 Spell	.30	.03	.40	.69
T2 SW	.80	.40	2.43	.02
T3 Spell	.25	.08	.82	.42
T3 SW	-.10	-.05	-.30	.77
T4 Spell	.27	.06	.74	.46
T4 SW	1.16	.58	5.79	.00

Standard Multiple Regression Analyses (SMR) were used to reinforce the findings from the correlation analyses and to identify how well the independent variables were predicting scores for the reading achievement measure (WCPM T5). SMR analysis indicated all predictors in the study accounted for 76% of the variance for WCPM (T5). The analyses also revealed that SW (T4), SW (T2), and SP (T1) were the three strongest predictors of WCPM at T5. Surprisingly, only one of the four spelling assessment time points was a strong predictor of end of second grade reading achievement. While the SP task is still an early predictor of later reading achievement, SW knowledge proved to be a better predictor according to the SMR analysis, consistent with the correlation analyses.

Hierarchical Regression (HR) analyses were conducted to further investigate and evaluate the relations among independent variables identified as strong predictors by the initial SMR and to identify which tasks at which time points were most significant in the model. Sight Words at

T4 was entered into the first HR model because SW (T4) was most significant ($p < .01$) in the initial SMR model. In this first HR model, 74% of the variance was accounted for by SW (T4). This finding was not surprising given how close in time to the criterion measure time point the task was administered. The pattern seen here also was revealed in the descriptive statistics—relations among and between tasks were stronger the closer in time they were measured. The regression analyses support the findings from the correlation analyses that sight word reading is a very good predictor of children's reading performance (measured by contextual reading scores).

The SW measure is a timed task, making it a useful tool for evaluating a child's level of automaticity (Guszak, 1997; LaBerge & Samuels, 1974). An accurate and automatic identification of a word is also indicative of the quality of lexical representation (Perfetti, 1985). And, while the acquisition of reading is a lifelong process, readers making the transition into Chall's (1983) Stage 2 of reading development can demonstrate the ability to read connected text with fluency, automaticity, and understanding (e.g., Ehri, 1998; Perfetti, 1985; LaBerge & Samuels, 1974). In fact, as early as late second grade, children must be able to read in this seemingly mature manner in order to begin reading for learning (Chall, 1983).

In summary, for early readers a more developed sight word vocabulary should indicate reading success later in one's schooling. Indeed, this study demonstrates that a simple sight word task, timed for one minute, can predict with accuracy students' reading fluency scores a year later. According to the Simple View of Reading (Gough & Tunmer, 1986), early reading skill is heavily influenced by the efficiency of the print processing aspect of their model, and this is what the sight word reading task is capturing. As reading ability develops, as Chall (1983) has outlined, the language comprehension (L) component becomes increasingly more important to the task of reading for meaning (Gough & Tunmer, 1986). But, in these early stages, print

processing efficiency is paramount to the success of the reader, and accurately measuring this ability is important for teachers and students.

Conclusions

Given the instructional needs of children in the early elementary grades whose literacy development can span several developmental stages (Chall, 1983; Ehri, 2005; Henderson, 1990), classroom teachers need effective assessment measures, which they can administer easily and interpret quickly. This study identified two of the strongest predictors of early reading achievement, spelling ability and sight word identification, along with assessment tasks that can be used to measure those skills. Effective assessments can be used in the earliest grades to identify struggling readers before they are caught by standardized tests at the end of third grade, which can result in grade retention.

Furthermore, the predictive power of sight words reinforces the need for a balanced literacy curriculum. Sight word acquisition is achieved through practice reading connected text at the appropriate level for each child (Adams, 1990; Ehri, 1998, 2005; Morris et al., 2012; Perfetti, 1992; Perfetti & Hart, 2002; Perfetti, Rieben, and Fayol, 1997). Children must have plenty of opportunities to read contextually in conjunction with explicit phonics instruction in order for reading skills to develop.

Reading connected text for meaning offers children opportunities to practice the skills that are often taught in isolation (e.g. synthetic phonics). Connecting fundamental skills in the act of reading authentic texts is the key to kick-starting Share's (1995) self-teaching mechanism, allowing lexical word representations to become fuller and more redundant in the young reader's mind (Perfetti, 1985, 1992, 2007). The lack of instruction and practice with connected text can

be revealed by students' scores on the sight word task, and this in turn provides a powerful reminder to teachers that the goal of reading instruction is reading.

In conclusion, teachers need effective assessments to identify students who may struggle with reading. These assessments must be accurate and easy to use, and they must be administered as early as possible. Classroom teachers must use these assessments to develop effective and appropriate balanced instruction for all learners. This study found that the SW measure in the winter of first grade is a strong predictor of reading a year and a half later, providing the opportunity to identify struggling readers well before third grade.

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Appendix A

Spelling Task

First Grade List

1. **trap (a mouse trap)**
2. **bed (under the bed)**
3. **wish (make a wish)**
4. **sister (my big sister)**
5. **drop (drop the ball)**
6. **bump (a bump in the road)**
7. **drive (drive the car)**
8. **plane (a plane in the sky)**
9. **ship (a ship on the ocean)**
10. **bike (ride a bike)**

Second Grade List

1. **train (a train ride)**
2. **thick (a thick board)**
3. **chase (chase the car)**
4. **dress (a blue dress)**
5. **queen (the Queen of England)**
6. **cloud (a white cloud)**
7. **short (a short stick)**
8. **shopping (go shopping with mom)**
9. **cool (it's cool outside)**
10. **stuff (lots of stuff)**

Appendix B

Sight Word Task

Directions: Mark through each error. Pace a large slash mark (/) to indicate last word attempted.

is	cat	my	good	come	and
up	play	big	are	from	old
little	where	hide	cut	bad	new
need	made	eat	find	does	back
two	men	white	feed	push	again
table	class	stand	cloud	leave	into
happy	school	them	window	tail	isn’t
part	children	drove	above	dug	gate
flow	change	wash	person	north	blanket
melt	asleep	dollar	blow	kept	giant
explain	coin	shade	office	straight	pillow
robber	finish	slide	print	soup	wing
prize	shoot	travel	spoon	toward	stomach
pool	vegetable	seal	accept	legend	slipper
dresser	customer	plop	further	closet	storyteller

Appendix C

Sample Contextual Oral Reading Passages

LATE FIRST GRADE (F & P level J/K)

Examiner's Introduction: This story is about two friends, Frog and Toad.

One hot summer day Frog and Toad sat by the pond.

"I wish we had some sweet, cold ice cream," said Frog.

"What a good idea," said Toad.

Toad went to the story. He bought two big ice-cream cones.

Toad licked one of the cones. "Frog likes chocolate best," said Toad, "and so do I."

Toad walked along the path. A large, soft drop of chocolate ice cream slipped down his arm.

"This ice cream is melting in the sun," said Toad.

Toad walked faster. Many drops of melting ice cream flew through the air.

Questions

1. What did Frog want on the hot summer day? (ice cream)
2. Where did Toad get the ice cream? (at the store)
3. How much ice cream did Toad buy? (two cones)
4. What problem was Toad having at the end of the story? (the ice cream was melting)

Words: 100

Errors:_____

Accuracy:_____%

Rate (6,000/sec):_____wpm

Comprehension:_____%

Second Grade

Examiner's Introduction: This story is about a hungry fox.

One day, Fox was walking through a forest. It was late summer. He knew that berries and other fruits would now be ripe. Suddenly, Fox felt hungry. He looked up and saw a bunch of grapes on a high branch. Each grape looked red and plump.

"Those grapes look good," said Fox. So Fox jumped up to grab them, but the grapes were too high. Fox tried again. This time he took a running start. He jumped as high as he could. Still, he could not reach the grapes. Fox tried and tried. Each time he missed the grapes by inches.

Finally, Fox became tired. He decided he wasn't so hungry after all. He said, "I be those grapes are sour anyway!"

Questions

1. At what time of year does this story take place? (spring [1/2]; summer [full credit])
2. What was Fox trying to get? (Grapes [1/2]; How did the grapes look? (red, ripe, or plump [1/2])
3. How did Fox try to get the grapes? (He jumped for them.)
4. Why dud Fox quit trying to get the grapes? (He became tired. <u>or</u> Grapes were too high for him to reach.)
5. What did Fox tell himself at the end of the story? ("I'm not really hungry." <u>or</u> "Those grapes are probably sour.")

Total Errors:_____

Meaning Changes:_____

Oral Read. Acc.:_____%

Comprehension:_____%

Rate (7,320/sec):_____wpm

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The Development of an Instrument for Teacher Preparation Programs: How Can We Measure Student Teachers' Impact on 4th and 5th Graders' Attitudes?

Joyce Fine

Eilyn Sanabria

Obi Lawrence

Florida International University

The Development of an Instrument for Teacher Preparation Programs: How Can We Measure Student Teachers' Impact on 4th and 5th Graders' Attitudes?

With the report from the National Council on Education Standards and Testing (1992), came the beginning of the standards movement. The report called for changes in assessments as well as other aspects, such as professional development. This led to a call for high-quality teacher preparation (Bean, 2015). Currently, standardized tests are being used to assess students' performance and as one of the determinants of teachers' salary, as required in the Federal Race to the Top grants to the states. Teacher preparation, therefore, plays a major role in the success of students on standardized assessments. The latest movement from the Council for the Accreditation of Educator Preparation (CAEP) is an effort to evaluate teacher preparation programs based on the impact of their program candidates on students. Collecting student achievement data, however, is very difficult to obtain from a school system without parental consent. Additionally, there are too many intervening variables to establish a causal relationship between a student teacher and student achievement.

One way to measure the impact of student teachers on their students might be to implement an assessment of content learned from a unit taught by a student teacher. That gives a one-dimensional data point, which yields a score demonstrating whether a student teacher can teach information on a topic. Another way would be to seek attitudinal response on surveys of the students towards their student teacher about different areas of interaction, not just one content area. This multidimensional approach may yield more useful information for teacher preparation programs. The challenging aspect with that situation is how to interview students directly to determine their response to the student teacher while providing confidentiality. This research study, through the development of an instrument for teacher preparation programs, examined student teachers' impact on 4th and 5th graders' attitudes towards their student teacher. The instrument was administered anonymously by the cooperating teacher.

Review of the Literature

The National Council on Teacher Quality's (NCTQ) *2013 Teacher's Prep Review* referred to teacher preparation programs in the United States as mediocre and sparked a national debate about the necessity to strengthen them in order to effectively prepare future teachers to help students succeed in the "…contemporary American classroom" (Greenberg, Walsh, & McKee, 2014, p. 1). Following this publication, which brought teacher preparation programs to the forefront, the country began to take "…a harder look at how its teacher preparation schools are improving the quality of the teachers they produce" (Greenberg et al., p. 1). Initiatives to improve these programs come from different sources, such as the federal government, school boards, individual institutions that offer teacher preparation programs, and states, with thirty-three states making significant changes to laws and regulations to their existing teacher preparation policies (Greenberg et al., p. 8). Some of the significant changes include academic proficiency exams, assessment of specific content knowledge, and additional guidelines for student teaching experiences, such as requiring that it be an adequate length and that student teachers are only assigned to cooperating teachers who have been classified as effective through measures the school and/or district use (Greenberg et al., p. 9).

Many teacher education programs are grounded in Vygotskian theory (Vygotsky, 1978), in which learning takes place in the learner's Zone of Proximal Development (ZPD). This is a sociocultural theoretical perspective. Through this perspective, an effective teacher must be aware of students' needs in order to grow (Kim & Schallert, 2011). Being aware of students' needs requires teachers to care about their students and, in turn, students to care about learning from their teacher. Noddings (1984, 1992) coined the term, "ethic of care" to describe the interdependence of the one-caring and the cared-for. Transferring this to the classroom, caring is

the quality of the way the teacher responds to the students and how the students respond to the teacher. Beginning in the 1990s, research was focused on the influence of instruction on reading motivation and engagement (Malloy, 2015). It was found that reading comprehension and motivation are correlated (Guthrie & Humenick, 2004). In recent research, it was found that teachers can influence student motivation by creating enhanced classroom contexts (Malloy, 2015). Hence, the student teaching experience is, perhaps, the most important component of teacher preparation programs because it allows for these caring interactions and enhanced classroom contexts to be established. It is during this experience that student teachers truly demonstrate not only their awareness of students' needs, but also their content area knowledge, their ability to make meaningful and positive relationships with their students, and their overall preparation to enter the classroom. Building positive relationships with students is essential for their academic success because, as Wentzel (1998) and Resnick et al., (1997) argued, the relationship between teachers and students can have an immediate influence on students' motivation and behavior. In addition, these supportive relationships can provide the environmental and social supports needed by students to succeed (Pianta, 1999). However, it can be very difficult for student teachers to establish these relationships in today's classrooms, as the pressures of accountability may distract teachers from creating a culture of caring in their classrooms (Hallinan, 2008).

Statement of the Problem

Student attitudes play a major role in the classroom. The often-cited definition of attitude is that it is "a psychological tendency that is expressed by evaluating a particular entity with some degree of favor or disfavor" (Eagly & Chaiken, 2007). The degree of favor or disfavor can be seen as a function of aspects of the classroom and the instructional practices (Malloy, 2015).

For instance, Brophy (1999) discusses how teachers can provide utility value, emphasizing the worth of learning the content. Such aspects used by teachers greatly impact student learning (Malloy, 2015) and can be seen as one way it impacts the effectiveness of the student teacher in helping students succeed academically. Researchers know very little about the topic of students' attitudes towards their student teachers. Therefore, this study sought to develop and validate an instrument for assessing the impact of student teachers on the students' attitudes.

Research Question

In the state of Florida, prospective teachers are required to pass two examinations to qualify for certification: a professional conduct/behavior exam and an academic instruction/behavior exam. Using this knowledge, the following research question was formulated to address the specified need:

- Does the factor structure of the students' responses support the two state certification requirements?

Methods

For the instrument development and validation process, several steps were taken. First, questions were written for each of the factor structures from the state certification exam and a Table of Specification (ToS) was used to do a factor analysis (Newman, Lim, & Pineda, 2013). This process involved the input of six Elementary Education experts on the survey questions to help determine if the questions aligned with the two concepts. The agreement was quantitatively determined. The experts then suggested changes to the questions based on what they believed needed to be added in order to measure the two concepts. Once the changes were made, the questions were qualitatively assessed. The final product consisted of ten items with a four smiley face Likert-style scale (Happy, Somewhat Happy, Somewhat Unhappy, and Unhappy). Hopkins

and Stanley (1981) found that pictorial response scales are effective for assessing attitudes for children. Further, Yang (2002) found that a smiley face-assessment scale was a reliable instrument for measuring the affective domain for students. To further test this instrument prior to conducting the study, a pilot study was conducted with 4th and 5th graders responding about their own classroom teachers. Feedback from the pilot study resulted in the simplification of the wording of the open-ended questions.

The final product was administered to fourth and fifth grade students with a student teacher in several schools throughout Miami-Dade County. The survey was administered by the classroom teacher; the student teacher was not present during the administration of the instrument, nor did he/she have access to the completed surveys. Student responses were anonymous; no identifiable data was gathered. Data gathered was quantitatively evaluated for reliability and specific item statistics. A factor analysis was also conducted in order to identify correlated variables to create factors. Even though Likert scales are considered ordinal data (Jamison, 2004), errors for treating the Likert scale results as integral are minimal (Jaccard & Wan, 1996) and it has become common practice to use parametric statistics to analyze ordinal data (Blaikie, 2003). Finally, specific item responses were grouped into the two areas (Professional Conduct/Behavior and Academic Instruction/Behavior) in order to analyze student attitudes towards their student teacher in each specific area. Student responses for items 1, 2, 3, 9, and 10 were grouped into Professional Conduct/Behavior and responses for items 4, 5, 6, 7, and 8 were grouped into Academic Instruction/Behavior.

Results

A total of 268 students completed the survey; table 1 shows the grade level distribution of students, 170 (63.4%) fourth-graders and 98 (36.6%) fifth-graders. Of the 268 participants, 117

(43.7%) were male and 147 (54.9%) were female, as shown in Table 2. Six of the students (2.2%) were Asian, 21 (7.8%) were Black, 166 (61.9%) were Hispanic, 44 (16.4%) were White, and 9 (3.4%) were classified as Other, as shown in Table 3. Lastly, the ethnicities of the student teacher were also diverse; two of the student teachers (.7%) were Asian, 47 (17.5%) were Black, 165 (61.6%) were Hispanic, 12 (4.5%) were White, and 26 (9.7%) were classified as Other, as shown in Table 4.

Table 1

Grade Level Distribution

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	4	170	63.4	63.4	63.4
	5	98	36.6	36.6	100.0
	Total	268	100.0	100.0	

Table 2

Gender

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1	117	43.7	44.3	44.3
	2	147	54.9	55.7	100.0
	Total	264	98.5	100.0	
Missing	System	4	1.5		
Total		268	100.0		

Table 3

Student Teacher Ethnicities

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1	2	.7	.8	.8
	2	47	17.5	18.7	19.4
	3	165	61.6	65.5	84.9
	4	12	4.5	4.8	89.7
	5	26	9.7	10.3	100.0
	Total	252	94.0	100.0	
Missing	System	16	6.0		
Total		268	100.0		

Table 4

Student Ethnicities

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1	6	2.2	2.4	2.4
	2	21	7.8	8.5	11.0
	3	166	61.9	67.5	78.5
	4	44	16.4	17.9	96.3
	5	9	3.4	3.7	100.0
	Total	246	91.8	100.0	
Missing	System	22	8.2		
Total		268	100.0		

To estimate the reliability of the instrument, a Cronbach Alpha was conducted. The Cronbach Alpha helps determine the internal consistency of the instrument, or whether all items used in the survey measure the same construct (Tavakol & Dennick, 2011). This coefficient is necessary in order to assess whether specific items need to be removed from the instrument prior to further analysis in order to increase its reliability. With a range of 0 to 1, Cronbach Alpha

values of 0.7 to 0.8 are deemed satisfactory (Bland & Altman, 1997). For this instrument, the subscale of the 10 items indicated a high internal reliability ($\alpha = 0.791$). Therefore, none of the ten items were removed, as the reliability of the instrument would have decreased, as shown in Table 5.

Table 5

Item-Total Statistics

	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Cronbach's Alpha if Item Deleted
Q1	33.72	8.331	.536	.764
Q2	33.62	8.868	.442	.776
Q3	33.80	8.172	.460	.775
Q4	33.57	8.713	.508	.769
Q5	33.67	8.309	.416	.781
Q6	33.68	8.383	.489	.770
Q7	33.58	8.810	.385	.782
Q8	33.72	7.421	.610	.753
Q9	33.62	9.019	.380	.782
Q10	33.48	9.273	.493	.777

Specific item statistics for all ten items show that the majority of student responses were marked as happy or somewhat happy, indicating their positive attitude towards their student teacher. The number of respondents (*n)* varied for each of the ten items, as some of the student teachers were in departmentalized classrooms and reading was not one of the subject areas they taught. When asked how they feel when the student teacher explains classroom rules or tells them what to do (Item 1), the majority of students (68.7%, $n = 268$) answered happy. When asked how they feel when they ask the student teacher for help with using materials in the class such as references or the computer (Item 2), the majority of students (77.6%, $n = 268$) also

answered happy. Similarly, when asked how they feel when they ask their student teacher questions about classroom procedures or situations (Item 3), most students (67.5%, *n* = 268) selected happy. Regarding their feelings when they work on reading with their student teacher (Item 4), most students also responded happy (71.6%, *n* = 229), and 63.8% (*n* = 225) chose happy to express how they feel when they work on math with their student teacher (Item 5). As it relates to working on writing (Item 6, *n* = 229), science (Item 7, *n* = 245), and social studies (Item 8, *n* = 221) with their student teacher, most students feel happy (64.6%, 73.5%, 61.9%, respectively). Likewise, students reported feeling happy when sharing their ideas with their student teacher (Item 9, 73.5%, *n* = 265) and when their student teacher helps them learn (Item 10, 86.6%, *n* = 267).

When conducting a factor analysis using all ten items, three factors emerged using the Kaiser rule (eigenvalues greater than 1). The Kaiser rule is important in the analysis because it eliminates all factors that account for less variance than one variable does, since its reliability would then be negative (Kaiser, 1960). As shown in Table 6, ten components were extracted in total, accounting for 100% of the variance. The first factor accounts for 36.084% of the variance, the second accounts for 11.854% of the variance, and the third factor accounts for 10.445% of the variance. The total amount of variance accounted for by the first three principal components solution is 58.383%.

Table 6

Total Variance Explained

Component	Initial Eigenvalues			Extraction Sums of Squared Loadings			Rotation Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	3.608	36.084	36.084	3.608	36.084	36.084	2.366	23.656	23.656
2	1.185	11.854	47.937	1.185	11.854	47.937	1.802	18.021	41.677
3	1.045	10.445	58.383	1.045	10.445	58.383	1.671	16.706	58.383
4	.818	8.182	66.565						
5	.744	7.442	74.006						
6	.649	6.493	80.499						
7	.561	5.609	86.108						
8	.518	5.175	91.284						
9	.442	4.422	95.705						
10	.429	4.295	100.000						

Extraction Method: Principal Component Analysis.

The Rotated Component Matrix (see Table 7) shows the factor loading for each item. The first factor, Instructional Behavior, relates to how the students felt about the way the student teacher helped them learn. The second factor, Content Area, relates to how the students felt regarding their student teacher's knowledge of the specific content area. Both of these factors are closely related, hence the cross load of items one and eight. The last factor, Professional Behavior, relates to how the students felt about the relationship the student teacher established with them. Therefore, factor analysis supports the construct validity of these items, with instruction having two sub-concepts: Academic Instruction/Behavior (factors 1 and 2) and Professional Conduct/Behavior (factor 2).

Table 7

Rotated Component Matrix[a]

	Component		
	1	2	3
Q10	.738	.047	.175
Q3	.678	.101	.133
Q4	.665	.022	.351
Q1	.627	.448	-.038
Q8	.568	.514	.141
Q5	.033	.755	.241
Q7	.163	.717	.011
Q9	.276	-.135	.787
Q2	.003	.398	.715
Q6	.316	.254	.537

Extraction Method: Principal Component Analysis.
Rotation Method: Varimax with Kaiser Normalization.

a. Rotation converged in 7 iterations.

Furthermore, to assess whether the attitudes of the students towards their student teachers in each of these two areas were negative or positive, student responses for various items were added. As shown in Table 8, the mean ($\bar{X}$ = 18.46) shows that students had a positive attitude towards the student teacher's professional conduct/behavior. This calculation was made by adding student responses from questions 1, 2, 3, 9, and 10. Similarly, the mean ($\bar{X}$ = 15.9) shows that students also had a positive attitude towards the student teacher's academic instruction/behavior (see Table 8). Lastly, when looking at the overall attitude of students towards their student teacher, the mean ($\bar{X}$ = 34.37) shows that students had an overall positive attitude as well (see Table 8).

Table 8

Descriptive Statistics

	N	Mean
Professional Conduct	268	18.46
Academic Instruction	268	15.90
Raw Score	268	34.37
Valid N (listwise)	268	

Discussion and Future Research

This study was devised to gather information about the students' response to their student teachers. The instrument was based on the areas of Professional Conduct and Academic Instruction, which are tested by the state for certification. Because the students' response was overwhelmingly positive, the results indicate that these students were very happy with their student teacher, both with their professional conduct and academic instruction. Although the Academic Instruction factor had cross loading for two items, results of the study suggest that the college of education was preparing their student teachers to meet the two certification areas. One might say that the college of education was teaching the areas that are represented on the test, the areas that are currently the focus of teacher education. This is important because, as teacher preparation programs reshape their curriculum to help their student teachers meet new certification demands, this instrument serves as a tool to measure student teachers' impact on students, an important component for teacher certification. Future research should focus on, perhaps, other institutions within the state using the same instrument to be able to compare their results. It might even be appropriate to try using the instrument in other states that may have other criteria for certification to see if the results are as positive for those institutions.

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